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ABSTRACT

This document is a practical manual to assist community-based organizations and coalitions in using voluntary industry skill standards in programs preparing people for success in the workplace and further education. The following are among the topics covered in the manual's six sections: (1) developing and maintaining systems (things partners can give to and get from the system, ways of organizing and managing systems to ensure their success); (2) planning and operating programs (preparing students for multiple future options, serving a variety of populations and needs, strengthening programs through work-based learning); (3) creating curriculum (structuring curricula to prepare students for workplace success, integrating skill standards); (4) creating instructional strategies (instructional strategies commonly used to prepare people for career success, support mastery of tasks and development of competencies, and support contextualized learning); (5) enhancing professional development (professional development approaches to prepare learners for success in the workplace and improve teachers' capacities); and (6) using assessment methods

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(standards-based assessment, assessment in real-life contexts). Appended are the following: list of the original pilot voluntary industry skills standards projects; resource directory of case studies and examples; list of additional relevant national organizations; bibliography which contains 58 related readings; and list of project advisory board members. (MN)

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Making Skill Standards Work

Education Development Center, Inc.

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Highlights from the Field

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MAKING
SKILL STANDARDS
WORK

HIGHLIGHTS FROM THE FIELD

A Practical Manual for
Program/Curriculum Developers, Teachers, Employers, Trainers, Work-Based
Supervisors, Mentors, School Administrators, and Counselors

Written by
EDUCATION DEVELOPMENT CENTER, INC.
CENTER FOR EDUCATION,
EMPLOYMENT, AND COMMUNITY

FALL 1999

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Title VI of the Civil Rights Act of 1964 states: "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." Title IX of the Education Amendments of 1972 states: "No person in the United States shall, on the basis of sex, be excluded from participation under any education program or activity receiving federal financial assistance."

Note: EDC used the most recent information available to compile this manual. However, there may be some inaccuracies of the data contained herein resulting from data unavailability or as a result of new research and information.

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Acknowledgements

This manual results from the work of thousands of people in sites around the country. Many of the people who contributed to its creation have worked with Education Development Center, Inc.(EDC) or the FFA Foundation, Inc. for years, while developing and implementing industry skill standards and school-to-career programs. Most of their names are listed in Appendix B, Resources, which refers to the examples and case studies contained herein. Many other people, who are not listed as specific resource contacts, also participated in the project. We would like to thank all the people with whom we met, not only for the help they gave us in creating this manual, but for the inspiring work they are doing in the areas of school-to-career, workforce development, and skill standards implementation in their communities and their industry areas.

The National Skill Standards Board (NSSB) provided the financial support for this project. In particular we appreciate the assistance of Edie West, executive director of NSSB, and the project's NSSB officers — Marjorie Haas, Sally Waldron, and Laura Pfalzer.

FFA Foundation, Inc., the subcontractor on this project, provided much information, support from their members, and assistance with site visits. In particular, we thank Jeff Moss, consultant to FFA, who served as codirector of this project. His contributions included enlisting participants for the Advisory Board, workshops and meetings, conducted some site visits, and contributed information for the manual. We also appreciate the time and assistance given by Jim Gibson, regional director of FFA, as well as the support of Bernie Staller, Chief Operating Officer of the national FFA.

Great appreciation goes to the staff at EDC, who contributed so much to the research and writing of his manuals's sections. Joyce Malyn-Smith, senior curriculum developer and co-PI on the project, wrote several sections of the manual, and provided much information, based on her extensive experience in school-to-career and skill standards. Vivian Guilfoy, EDC vice president and director of the Center for Education, Employment, and Community, helped provide conceptual clarity as well as valuable advice during the life of the project. Janet Whitla, president of EDC, provided enthusiastic and insightful support. Monika Aring helped shape some of the ideas reflected in the manual. Elisabeth Hiles was invaluable, as an administrative assistant and later as a researcher and writer. Elizabeth Altman conducted research for the project during its early stages. Kimberly Sansoucy did much of the editing and the appendixes. Cynthia Newson assisted with the editing and worked with Tajah Holmes on the design and formatting. Mya Nelson and Tommy Gonter did most of the revisions for the updated versions. Jennifer Roscoe supervised the design, editing, and production. Emily Osman designed the original cover. Dorothy Geiser designed the flyer and the cover of the manual final version. Jennifer Davis-Kay supervised editing of the final version.

The Project's Advisory Board, listed in Appendix D, provided very helpful advice throughout the planning of the project, and valuable feedback as we proceeded with our work.

Joyce Winterton, president of Winterton Associates, served as evaluator for the project. The comprehensive feedback she provided helped us focus the goals and process of the project.

An earlier version of this manual was published under the direction of the U.S. Department of Labor's Dissemination Team. Armelia Hailey is the team leader. Aida Hilliard and Andre Robinson arranged for the publication and dissemination of the report. The Dissemination Team is part of the Division of Policy, Legislation and Dissemination.

Judy Leff, Ph.D., Project Director

This manual is intended to assist anyone who is developing, expanding, or sustaining education-to-employment programs geared to high standards. If you would like additional copies, you can order them from Education Development Center, Inc. Please use the order form from the back of the manual.

This manual is part of a larger multimedia package being developed by EDC, in partnership with WGBH Television, to inform community-based coalitions about options for developing and sustaining comprehensive, successful education-to-employment systems. It also is intended to help facilitate that process. The full package will consist of the following items:

- a one-hour video documenting the development, over time, of a highly effective school-to-career system; it focuses on how the partnership is dealing with common issues in the endeavor;
- additional video vignettes of several, different education-to-employment coalitions dealing with some of the same issues;
- an interactive website, including print and graphic materials, and links to other websites—to enable information exchange and networking;
- a facilitation guide—to provide a framework for group discussions and partnership planning sessions, using the manual and video;
- technical assistance for developing and sustaining education-to-employment systems, programs, curriculum, professional development, and assessment.

For more information about this multimedia package, and to contribute your ideas and resources to it, please contact:

Judy Leff, Senior Project Director
Center for Education, Employment, and Community
Education Development Center, Inc.

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Introduction and Purpose

This manual was developed by Education Development Center, Inc. (EDC), with the assistance of the FFA Foundation and information from hundreds of organizations around the country. It is designed as a *practical manual* to assist organizations and coalitions in using voluntary industry skill standards in programs that prepare people for success in the workplace and for further education. Who should find this manual useful? People working specifically in the area of education-to-employment, or those focusing on academic education to expand their students' learning experiences, as well as those preparing adults and out-of-school youth for future opportunities in education and the workplace. It is a manual for educators, employers, counselors, supervisors, mentors, students, parents, community leaders, and others concerned with preparing people for more productive and rewarding lives.

This manual does not intend to provide another set of recommendations, as a number of documents have done. Instead, we designed the manual to share *concrete, specific information* about how organizations and coalitions are developing education-to-employment systems, programs, materials, and strategies using skill standards. It also describes how these groups are confronting common issues and barriers in creative and productive ways.

This emphasis is very important at this time in the national process of education-to-employment development because this process is entering a new phase. A great amount of funding and effort has been invested in the development of a number of excellent policies, systems, and programs, such as tech prep, school-to-work, and new ways of learning (inquiry-based, hands-on, school and community-based learning). There is also general acceptance that the benchmarks for both conceptual learning and technical skill development must be raised in our country; much has been invested in developing academic standards for various disciplines and skill standards for a number of industries.

To capitalize on this momentum, we need to dispel the confusion that exists at the level of practice about how to implement these policies and frameworks. There are many examples of organizations and coalitions that have developed education-to-employment programs and strategies. These groups are using standards to give people new opportunities for successful futures in industries that require a skilled workforce. These examples need to be disseminated so that people around the country can build upon them.

This manual aims not only to provide information about how to use skill standards but also to highlight ways organizations are integrating the components of education-to-employment, and new strategies for academic education, in productive and promising ways. In doing this, we will contribute to building a nation-wide network of education-to-employment initiatives that learn from each other and bring some excellent beginnings to scale.

What Is and Is Not in This Manual, and Why?

This manual contains nearly 100 case studies and examples of actual functioning systems and programs from around the United States, as well as practical advice from our own fieldwork and that of many other practitioners. The manual responds to the most frequently expressed needs and questions that practitioners and program participants have raised during our years of work together. These people who are "on the ground" include program developers and administrators, curriculum and pedagogy developers, teachers in classrooms, workplace managers, supervisors, mentors, academic and career counselors, labor union members, students, and parents. The organization of the topics as well as the examples presented herein reflect this emphasis.

In choosing the cases and examples, we focused on those that met many of the criteria we have learned create the most inclusive, stable, and promising processes. These criteria are:

Systemic Organization

- A consortium of schools, industry, labor unions, government, and other;
- Interested parties committed at the highest organizational levels to making the system work;
- A third party, preferably one or two full-time personnel, to direct and coordinate the many components of the system and help meet the needs of its partners.

Comprehensive Programs

- An education and training plan that integrates learning in school, workplaces, and community-based settings;
- Articulation among academic institutions to ensure coordination of learning at various grade levels, awarding and transfer of credits, and opportunities for continued learning;
- Development and support of the capacities of teachers, counselors, and work-based mentors and supervisors of program participants;
- Opportunities for student and teacher interaction with industry, to learn about various occupations and their requirements, and become familiar with various work settings;
- Methods to ensure that *all* students have access to career exploration and that *all* students have opportunities to choose and prepare for any career.

Innovative, Effective Curriculum Content and Learning Processes

- Curriculum that integrates academic and technical learning, and is designed to meet both academic standards and industry-based skill standards;
- Pedagogical methods that mirror workplace practices in high-performance work organizations (e.g., problem-centered, project-based, contextual learning, team teaching and learning);
- Assessment processes, including performance-based and portfolio assessment, that measure students' mastery in an integrated, contextualized format and can be administered by educators and in the workplace.

The manual examines the current status or process of developing standards-based education-to-employment initiatives. We include some preliminary outcome data, but this document is not intended to evaluate the outcomes of systems, programs, or pedagogy. This is because most of the systems and programs are too new to have sufficient data to provide more than anecdotal information. Assessment of the outcomes of these efforts is an essential next step to take, when more endeavors are brought to scale and produce significant results.

Most of the case studies and examples focus on programs that are technical, intended primarily to prepare people for high skilled employment, as well as for further education. However, much of the information will be useful for teachers and counselors working with all types of students, including those planning only to pursue advanced academic studies in the near future. This is because the primary elements in an education-to-employment program—relating classroom learning to real-world uses, project-based learning, working in teams, integrating academic and technical learning, building career awareness and exploration, involving community representatives in the education process—are elements that should be present in any comprehensive education system.

A large number of the case studies and examples come from the bioscience industry (although a considerable number are taken from other industries). This is because much of our effort has been with organizations and coalitions working in this field. However, the issues and the methods used in the case studies and examples are applicable to education geared toward industry or occupational cluster. We know this from working on education-to-employment in a number of industries, and discussing the same issues with colleagues from many other industries. The issues missed in each of the sections are generic, as are the methods used in most of the case studies and examples.

Finally, the examples and case studies are only a sampling of many excellent endeavors around the country. There are, of course, many more, in a wide range of industries and occupational clusters. We chose to focus on examples that we knew best from our own work; these illustrated particular common issues and outstanding attempts to deal with them. There is need to do a much more comprehensive study of such efforts, to learn even more about the variety of creative, successful, and not-so-successful approaches to common issues being tried, and to publicize and disseminate them in ways that can promote sustainability and going to scale.

Who Can Use the Manual?

System and Program Developers

You probably will want to start with the first two sections, Developing and Maintaining Systems and Planning and Operating Programs, for information related to building and maintaining coalitions, creating programs that serve various functions and needs, and other "large arena" issues. To the extent that you are responsible for the development of curriculum, pedagogy, assessment, and professional development, the later sections will also be useful.

Curriculum and Pedagogy Developers

You will find the sections, Creating Curriculum and Creating Instructional Strategies, the most relevant to your work. You will also want to read the section Enhancing Professional Development for ideas about how to prepare teachers and instructors to use the new content and methods, and the assessment section for developing ways to evaluate the mastery of the standards-based knowledge and skills.

Teachers and Instructors

You probably will be most interested in the Creating Curriculum, Creating Instructional Strategies, and Using Assessment Methods sections, which deal with the work you do in the classroom. Because many of you create your own curriculum, pedagogy, and assessments, you can also consider these sections from the perspective of a developer as well as a user. The sections on Planning and Operating Programs will also be helpful if you are involved in that. In addition, the section on professional development should be of interest.

Employers and Workplace Supervisors

You will find the first two sections, Developing and Maintaining Systems and Planning and Operating Programs, particularly helpful, because these parts discuss many issues you will deal with as participants in coalitions to develop and maintain successful efforts. The sections Creating Curriculum and Creating Instructional Strategies, especially work-based learning, deal with the content and processes of student learning at the work site: To the extent that industry participates in developing curriculum and providing training, these sections will be useful. Also Using Assessment Methods section can help with evaluating interns, job applicants, and current employees.

Unions and Workers

You will be interested in the Developing and Maintaining Systems section because your active participation in shaping and maintaining them is essential. To the extent that workers supervise student and teacher interns, you will want to read parts of the Planning and Operating Programs section, especially those related to work-based learning. The Creating Curriculum section provides information that current workers will find interesting in planning their own education for career advancement.

Students and Parents

You should find the sections Planning and Operating Programs, Creating Curriculum, Creating Instructional Strategies, and Using Assessment Methods most useful: These sections will give you a good idea of education, work, and career options that are broader (and possibly more appealing) than ones you traditionally hear about. These sections also provide information about the types of new learning experiences students should have to prepare for most new career options.

Academic and Career Counselors

You will want to focus on the larger picture given in the first two sections, Developing and Maintaining Systems and Planning and Operating Programs, to gain a clear understanding of the broad range of education and careers options available to students, other than traditional academic or vocational education programs: You will also want to read the sections Creating Curriculum, Creating Instructional Strategies, and Using Assessment Methods to gain familiarity with newer education content and methods. Enhancing Professional Development section pertains to you, as well as to teachers and instructors.

Government and Community Leaders

You will gain information from the sections on Developing and Maintaining Systems and Planning and Operating Programs: These are the efforts in which you should be most involved, and which you can support, perhaps in some ways described in this manual. The other sections also will be relevant for you, because the needs discussed in them will require some participation and support by local government and community organizations.

Organization of the Manual and How to Use It

The manual is organized into the Introduction, six sections, and four appendixes. Each of the six sections corresponds to a primary component of an education-to-employment initiative. The six sections are:

- Developing and Maintaining Systems;
- Planning and Operating Programs;
- Creating Curriculum;
- Creating Instructional Strategies;
- Enhancing Professional Development;
- Using Assessment Methods;

Each section begins with relevant information that EDC and FFA have gathered or developed during the course of our work, creating and implementing skill standards and school-to-career programs.

Each section is structured around a list of key questions. These questions highlight the most common issues and concerns that participating organizations and consortia face. For example, in the Planning and Operating Programs section, one of the key questions is "How can you make your program operate smoothly, and why is a paid third party essential?" The question is briefly examined, then followed by "How Skill Standards Can Help," a subheading which presents particular ways that industry skill standards are or can be used to deal with the question.

We then present case studies which illustrate inventive, comprehensive, and successful approaches organizations and consortia are using to answer the key question. The case studies are followed by examples, that also highlight innovative approaches to the issues but are less complex and are covered in less depth. Each case study or example is identified by the name of the lead organization and by the particular issue(s) it treats.

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Following this Introduction is a program index that lists the primary organization/site for each of the case studies (cs) and examples (ex) described in the manual, and indicates under which sections and key questions they appear. Some entries appear once or twice, whereas others appear in a number of places, depending on the relevance of the organization/site to various sections and issues.

We suggest you begin by looking through the table of contents and program index, to become familiar with the key questions discussed and the case studies/examples described. You can then turn either to a particular section or key question that interests you, or follow one organization to see how it deals with a number of issues.

The manual also contains four appendixes that includes:

- a listing and contact information for the 22 original national industry skill standards, funded by the Departments of Education or Labor, several sets of standards developed by other organizations, and current industry skill standards being developed with support from the National Skill Standards Board;
- a resource listing of the organizations/sites and contact information for all of the case studies and examples described;
- a partial listing of relevant readings that deal with the topics and issues discussed.

How the Manual was Developed

Much of the information was assembled or developed by EDC, as we worked with organizations and consortia to develop school-to-career programs, create and implement industry skill standards, and enhance teacher professional development. This work was conducted at the national, state, and local levels. FFA, the subcontractor on this project, also contributed learning from many years' experience working with educators and the agricultural industry on school-to-career, skill standards development and implementation, teacher professional development, and other education initiatives.

As part of EDC's work, we often assembled policy developers, education program developers and directors, teachers, frontline workers, work supervisors, government representatives, and other interested parties to discuss common issues and share experiences and strategies for confronting them. Many of these meetings and workshops produced materials that have been disseminated. During the last several years, EDC and FFA continued this approach, while studying nearly 100 programs and coalitions all around the country. We have visited classrooms and work sites, attended advisory board meetings and committee meetings, and convened stakeholders to discuss their collaborative efforts and their concerns.

In this manual, we have tried to capture and disseminate both the information compiled from our research and experience and the spirit of colleagueship these interactions have engendered. We hope this work provides a valuable contribution to the continuing process of developing, tracking, and assessing the success of standards-based education-to-employment.

Program Index

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Developing and Maintaining Systems

To meet the needs of the various member groups within a community, a system that includes all of the stakeholders must be developed to dialogue, plan, and measure progress. Without such a system, it is likely that individual programs will not be coordinated with each other in an efficient and equitable way. Furthermore, there will be no forum in which all stakeholders—employers, educators, government, unions, community-based organizations, students, parents, and other groups—can work collectively to resolve the many issues and potential conflicts that are bound to arise.

A system is necessary to

- identify the skill and knowledge needs of local industry which will be used to design effective school-to-career education programs in area schools and training programs;
- ensure that education programs, curriculum, instructional strategies, and assessment protocols are designed from the beginning to be consistent with the skills and knowledge required for industry employment;
- identify the employment and career opportunities for graduates of these programs;
- identify work-based learning opportunities for students and teachers in local workplaces;
- identify ways that local employers and workers can participate in education programs in their communities;
- develop and carry out a mission and strategy that represents the needs and goals of all parties;
- present a unified strategy that can enable the system to apply to outside organizations for support;
- ensure the continued commitment to and involvement in the activities needed to maintain a successful system, and to be responsive to the changing needs of all the partners;
- collect and analyze data on outcomes for further use.

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One Example of a Well-Functioning Standards-Based System

In a well-functioning system, each partner's contribution of expertise and opportunity, returns to them in equal measure. For example, the local employer who provides a supervised internship to a high school or community college student, or a participant in a public, community-based, or union training program preparing for a career in that industry gains the labor they need for immediate production. They also have the opportunity to prepare potential future workers in the particular skills and methods used in their workplace. The employer is also apt to earn the goodwill of the community for contributing to the education of its citizens.

The student gains work experience; learns new skills; makes possible future job contacts; and obtains a certificate and a reference to put into his/her portfolio, records for school, or program graduation requirements—and may even earn income. The student is also likely to gain an increased motivation to stay in school or in a training program since he or she will be able to see the connection between what is learned in the classroom and how it applies to the work world (and in this particular industry), and the career opportunities that exist. The young student's parents gain a new perspective on how education can lead to rewarding career possibilities for their child.

The industry employee assigned to supervise the intern provides leadership, mentorship, skill and knowledge development, and other supports to the student. The worker gains supervisory experience, a chance to be a positive influence in the student's life, and a preview of a potential coworker's qualifications. A union at the company, or in the industry, can help its members acquire supervisory experience and skills needed to advance to higher level jobs, and possibly help prepare potential members.

The student's school contributes the basic education and school-based learning required to prepare the student in the conceptual and technical skills necessary for an educated citizen and worker. In return, the school's education responsibility for the student is shared by a workplace that provides valuable learning experiences. The school may increase its retention rate for at-risk students. It can also offer students an opportunity to extend their learning experience beyond the classroom and into the community with adult role models. An adult training program may also increase its retention and placement rates.

Teachers and other educators gain expertise and skills as they develop and operate the programs and internships. They gain a broader view of career possibilities for their students and experience the joy of their efforts when they observe the student intern engaged in learning and read the supervisor evaluations.

The community (local government, community-based organizations, or CBOs) provides support to the education institution and perhaps even directly supports the internship experience. In return, the community is more likely to have better educated citizens, a higher-skilled workforce, more satisfied employers, and citizens who contribute to building a stable social community and local economy.

The following section focuses on several key questions that concern practitioners as well as policy developers. It also includes examples and/or case studies of how local, regional, state, or national organizations and coalitions are successfully dealing with each major question.

Key Questions

1. What can each partner give to and get from the system, and what supports do they need?
2. How can a system be developed to engage partners who will be valuable, committed, and active participants?
3. How can the system be organized and managed to ensure it will function well, and why is a third party essential?
4. How can support be obtained for the system?

1 What Can Each Partner Give to and Get from the System and What Supports Do They Need?

For a system to achieve its goals, as well as the goals of its individual partners, all partners must specify what they will give to the system to make it work and what they want from it to make their participation worthwhile. In addition, the types of support the partners will need to participate and contribute their particular resources must be identified. Previous work with educators, employers, labor, government organizations, and other groups have helped identify their needs, resources, and gaps in support. In a series of workshops and meetings assembling these constituencies, we created a chart (*See exhibit 2A*). The information summarized in chart-form is later fleshed out in the series of case studies and examples from around the country.

How Skill Standards Can Help

Skill standards can be used to help ensure that every partner receives the needed supports to give and get the most from the system. It is important that all the system partners understand the components and content of the skill standards, and agree that the content accurately defines what is important for students to learn to become valuable employees and be prepared for further education opportunities. This is essential for the standards to be accepted as a common language. When this exists, the standards can be used by the partners, working together, to define goals for the system and to develop a plan that responds to the needs of each partner, makes use of their resources, and enables them to participate fully. As the partners continue to work together to implement the program, they can use the skill standards to measure the degree to which standards-based learning meets the needs of students and others preparing for further education and careers as well as employers looking for well-prepared employees.

The following exhibit presents an overview of what each of the partners can give to and get from the system and the supports they will need to be most effective. It can be used as a guide by groups who are forming their own school-to-career systems or trying to improve those already in existence.

Exhibit 2A: Roles and Needs of System Partners

PARTNER	CAN GIVE	CAN GET	SUPPORTS NEEDED
TEACHERS, SCHOOL ADMINISTRATORS **EDUCATION PROGRAM PLANNERS** **CURRICULUM DEVELOPERS** **COUNSELORS**	career awareness and exploration for *ALL* younger students basic academic education for *ALL* students that meet standards *ALL* students employability skills, and some technical skills for future careers preparation of students for future life and work by using materials and instructional strategies that reflect the real world ability to teach technical skills and knowledge after learning about industries and local employers partnership with industry to determine knowledge and skill needs to develop programs, relevant school and work-based learning support for industry in working with educators and the education system preparation for students in technical programs with skills that meet industry standards academic and industry skill standards to assess students' mastery of skills and knowledge support of industry to develop training programs for current employees	information and resources (expertise, equipment, classroom materials, etc.) by building networks with other schools and employers enhanced professional development by learning new information and skills, and expanding work roles information about new industry developments and expertise about evolving technology opportunity to participate in industry training (when possible) participation of employers, workers, CBOs, and others in evaluating students and/or assessing portfolios reward of knowing students are better prepared for future education and career opportunities	release time from teaching and other duties, and additional paid time, to work together and with other members of the partnership appropriate equipment and supplies to teach students first-hand experience with workers to learn about evolving technology, and what happens on the job and in work places a translator to assist with communication with employers, government, and other partners who have differing cultures and sometimes differing priorities support staff to market programs to the community, recruit new students, arrange for work-based learning, and do many other administrative tasks awareness of education efforts by community, parents and other educators recognition of the extra efforts involved in creating the programs, curriculum, and innovative teaching strategies

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(continued exhibit 2A)

PARTNER	CAN GIVE	CAN GET	SUPPORTS NEEDED
LOCAL AND REGIONAL INDUSTRY **EMPLOYERS**	information about projected industry and occupational growth in the region information about jobs and career opportunities in particular industries information about skill and knowledge requirements for different occupations in the industry information about current and future job opportunities with area employers career exploration opportunities—field trips, classroom speakers, mentorships, job shadowing supervised internships and coop jobs for students and teachers participation in community-wide education reform to help prepare future workers, community members, and children technical assistance with education program and curriculum development through participation on advisory boards, committees feedback on how training programs are progressing to help educators revise them resources for classrooms and labs (materials, equipment, equipment maintenance, etc.)	opportunity to help shape the education system that will prepare future employees, as well as children opportunity to ensure that students being trained in employability skills and specialized technical skills in a particular industry are prepared to those specific standards opportunities for employees to teach and develop other new roles in the community, which may increase satisfaction supervisory experience for workers who mentor or supervise students or teacher interns a chance to preview the skills of potential future employees recognition by the community for community involvement and good citizenship a cooperative environment from local government	a "translator" to assist with communication with educators, government, and other partners, who have differing cultures and sometimes differing priorities coordinator or facilitator, with authority and responsibility, as a point person to structure interactions with other members of the partnership and ensure that the partnership work is done training in how to work with students; need to learn "reality" of the education system and how to work with it participation designed to fit with work demands (time, schedules, etc.) to see concrete results in order to maintain the motivation to participate in the system (not just "feel good stuff", but results such as a high percent of graduates with demonstrable skill, knowledge to meet employer needs) support of management (e.g. time off, recognition, etc.) to enable full participation in education efforts

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(continued exhibit 2A)

PARTNER	CAN GIVE	CAN GET	SUPPORTS NEEDED
LOCAL AND REGIONAL INDUSTRY **EMPLOYERS**	students tutoring science fair assistance and judging teaching classes and courses, conducting hands-on workshops for students in classrooms and via the Internet jobs and careers for education program graduates funding for programs, scholarships, internships access for educators and students to larger networks of other industry people		
LOCAL AND STATE GOVERNMENT **ECONOMIC DEVELOPMENT AGENCIES**	information about current numbers and types of jobs in area industries information about regional industry and occupational trends information about new industry facilities development that will require skilled employees financial support for technical education programs, facilities, materials and equipment, and teacher professional development supportive environment for employers who contribute to local education efforts	increased employment opportunities for well prepared citizens a stable business community; assured of skilled workforce and community support increased tax base from successful employers and workers a more favorable climate for other collaboration among area employers and other interest groups	a "translator" - to bridge the communication and stylistic differences among various partners political support of legislators, public sector management, and constituents for system goals and process employer support for lobbying other government institutions financial support from federal government and national legislation, policies, and implementation guidelines

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(continued exhibit 2A)

PARTNER	CAN GIVE	CAN GET	SUPPORTS NEEDED
UNIONS AND THEIR MEMBERS	technical expertise about skill and knowledge needs of occupations sharing work experience with students and teachers through classroom speakers, mentorships, and/or internships experience with apprenticeships as a method for training students assistance to educators with planning programs, curriculum, and pedagogy to meet industry standards feedback on program and student performance to help with revisions support for training of union and non-union personnel	increased opportunity for employees to write training programs and internships into development objectives supervisory experience for workers, which help them qualify for job upgrades, bonuses, and other rewards opportunities for workers to teach, participate in education planning, and develop other roles in the community that can increase job satisfaction	formal agreement between employer and union to support and enable workers to participate in public education initiatives recognition by employers and others of the importance of contributions to education and skills learned (job and salary upgrades, bonuses, etc.) access to continuing education opportunities for career advancement
COMMUNITIES **COMMUNITY-BASED ORGANIZATIONS**	partnerships with other system partners to coordinate education and skill training in community coordination of resources of various organizations to optimize services provided rather than duplicate them partnership with other system partners, especially local government, to publicize education and training opportunities for community residents	reduced at-risk population of young people and adults an improved education system and schools increased community cohesion and coordination of resources among various constituent groups a more aware citizenry and electorate that can participate effectively as voters, jurors, planners, and administrators and in other community support roles	greater understanding of the goals and benefits of such a system, and assistance in organizing various community organizations to participate in the system concrete results (better educated students, higher employment in higher skilled jobs, greater employer commitment to the welfare of the community)

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(continued exhibit 2A)

PARTNER	CAN GIVE	CAN GET	SUPPORTS NEEDED
STUDENTS **PARENTS/GUARDIANS**	interest in and commitment to participating in systems and programs commitment to working hard in school, or encouraging children to work hard commitment to/support of working hard in internships, co-op work, and other work-based learning (students) cooperation with and support of other students and work site colleagues feedback about own children's experiences from educators and employers to help improve programs and curriculum assistance and encouragement to younger students to try new education experiences	increased motivation, because students can see the connection between what they learn in school and their future lives and work, because of more challenging curricula and learning strategies that help students succeed work experience for future employment, resumes contacts and references for future education and work the potential for income while in school self esteem building healthy relationships with other students, parents, teachers, supervisors, and co-workers	good education and training that meets established standards opportunities to learn in new ways in school and in work places teachers, work-based mentors, and others who are committed to helping students learn needed academic and technical knowledge and skills emotional support from teachers, mentors, counselors, and others sometimes financial support knowledge that real education and career possibilities exist for students at the end of their education/training

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2 How Can a System Be Developed to Engage Partners Who Will Be Valuable, Committed, and Active Participants?

Development of local or regional systems that will appeal to all stakeholders and encourage them to participate depends on the support of many entities. Government, at the national, state, and local levels, must enact legislation, allocate funds, develop guidelines, and provide technical assistance to support education-to-employment systems. The funding and assistance must be sufficient to help local coalitions get started and maintain them through their start-up phase (and longer, if necessary). Foundations, trade associations, and corporations must also provide financial and technical assistance. Employers must commit to working with educators and other interest groups to develop and maintain systems that will help prepare skilled, knowledgeable workers and educated citizens.

Schools and educators must learn what is required of students to become valuable workers, and be willing to change traditional administrative and pedagogical methods to adopt new strategies when necessary. In turn, they must have access to assistance and development opportunities to learn about these methods, and how to use them.

Students and parents must be educated about future education and career opportunities for knowledgeable, skilled people, including opportunities that are alternatives to traditional ones (e.g., opportunities for people with one to two years of college and a good technical education, instead of a four-year postsecondary academic education). In turn, they must commit to hard work (with encouragement from parents) and responsibility for their own learning.

Above all, each stakeholder must be willing to work with every other stakeholder, with a commitment to understanding each other's perspective, and to keep an open mind to new possibilities. Each also must be willing to stay with the system for the long haul. The development and maintenance of a viable, successful system requires continued, coordinated efforts by all parties.

How Skill Standards Can Help

Skill standards can be used to emphasize the relevancy and importance of involvement in education-to-employment systems for employers, educators, and all other stakeholders. Using the skill standards conveys to industry, educators, and other stakeholders the employers' needs for skilled, knowledgeable workers, and the educators' needs for designing appropriate programs and curriculum. These stakeholders will then be more likely to commit to participating in the system.

The development of a local or regional school-to-career system can be initiated by

- national, state, or local government, by funding and/or collaborating with high schools, two-and four-year colleges;
- a private sector corporation or trade association; or
- other institutions, such as community-based organizations.

Following are a number of examples and case studies of organizations that took the lead in promoting or organizing education-to-employment systems. These examples provide information about an array of strategies used by organizations to assess labor market needs, build partnerships, and take the various steps necessary to create and maintain a system.

National Impetus

Often the impetus for system development comes from national legislation, administered through national agencies, or from programs originating at the national level.

U.S. Department of Education (DoEd), Office of Vocational and Adult Education (OVAE) - *supporting education-to-employment in various ways for many years*

For many years the U.S. Department of Education, Office of Adult and Vocational Education has sponsored many programs that have supported system development and programs that prepare people for the workforce. The 1990 reauthorization of the Carl D. Perkins Legislation provided $125 million to fund Tech Prep programs (spanning the last two years of high school and two years of college). These programs, which articulate secondary and postsecondary education and emphasize integration of academic and vocational learning, had been growing in popularity around the country. Tech Prep accelerated the proliferation of education-to-employment initiatives during the 1990s.

In 1992 and 1993 DoEd awarded grants to 13 coalitions of educators, employers, trade associations, unions, and other stakeholder organizations to develop national voluntary skill standards for entry-level workers in various industries. The skill standards developed by these pilot projects were intended to identify the academic knowledge, technical knowledge and skills, and employability skills required for workers in clusters of beginning level occupations in each of the chosen industries. The purpose of the skill standards development process was not only to collectively create standards of individual mastery for workers but also to lay the groundwork for developing systems, comprised of the stakeholder groups, that would make use of the standards in creating programs, curriculum, work-based learning, teacher development, and other elements required to prepare people to meet those standards. *(See Appendix A for contact information for all the pilot skill standards projects.)*

The passage of the Improving America's Schools Act in 1994 authorized the Secretary of Education to take steps to consolidate many separate education programs. Among the programs are those dealing with education-to-employment under the Carl Perkins Act, the Goals 2000: Educate America Act, and the School-to-Work Act.

DoEd, together with the U.S. Department of Labor, funds the National School-to-Work Office (NSTWO), established to develop national policies and help support state level efforts to coordinate existing education-to-employment efforts. The NSTWO also funds local and regional system and program development in the areas of school-to-work.

U.S. Department of Labor (DOL), Education and Training Administration (ETA) - *supporting public sector training programs for targeted populations*

The U.S. Department of Labor, ETA, has been supporting national programs, administered through state governments, to educate and train special populations (such as low-income citizens, out-of-school youth, dislocated workers, and welfare recipients) for decades.

Beginning with the Job Training Partnership Act (JTPA), in the early 1980s, DOL began to focus on development of local systems—the Private Industry Councils (PICs)—comprised of employers, educators, and other stakeholders to develop and implement education-to-employment in their areas. Currently, some local education-to-employment systems and programs utilize JTPA funds to provide services to eligible program participants. *(See examples under key question 4 of this section.)*

In 1991, based on research conducted by the Secretary of Labor's Commission on Achieving the Necessary Skills (SCANS), DOL released the SCANS report: *What Work Requires of Schools*. The report discussed the changes the U.S. economy and workplaces were undergoing and the subsequent need for all students to develop particular competencies and foundation skills required for success in the new world of work. The five competency areas are use of resources, interpersonal skills, use of information, knowledge of how systems work, and facility with new technologies. (*See exhibit 2B.*) The three areas of foundation skills are: basic skills (reading, writing, mathematics, listening, speaking); thinking skills (creative thinking, decision making, problem solving, knowing how to learn, reasoning); and personal qualities (responsibility, self-esteem, sociability, self-management, and integrity). (*See exhibit 2C.*) The content of the SCANS report became a guideline for educators and others developing or revising education and training programs and curriculum in schools and other education settings.

In 1992 and 1993 DOL funded nine pilot projects to develop voluntary industry-based skill standards nationwide. DOL and DoEd coordinated their skill standards development processes. As with the skill standards-development pilot projects supported by DoEd, the standards development funded by DOL was intended to both set performance criteria for people entering occupational clusters in industries and create multipartite coalitions of stakeholders to develop systems and programs to implement the standards at the state and local levels.

DOL shares with DoEd the support of the National School-to-Work Office, which is responsible for funding and helping develop school-to-work (STW) systems in all 50 states and U.S. territories, as well as supporting STW system development in local communities.

EXAMPLE

National Skill Standards Board (NSSB) - *supporting use of existing skill standards, in the context of education-to-employment systems, and forming voluntary partnerships of all stakeholder groups to develop national skill standards for 15 job groupings*

The National Skill Standards Board, created by the National Skill Standards Act of 1994, is charged to

- identify broad groups of jobs in which skill standards will be developed;
- promote the establishment of voluntary partnerships to develop skill standards;
- research, coordinate, and disseminate information on skill standards;
- endorse skill standards that are created by the voluntary partnerships;
- develop a national framework to support skill standards.

In 1996 the Board awarded grants to 9 of the original 22 pilot skill standards projects that had been funded by either the DoEd or DOL, to enable continuation of the projects' work and to further develop various components of the skill standards. This manual is the result of one of those grants.

Exhibit 2B: SCANS Report: Five Competencies

Resources: Identifies, organizes, plans and allocates resources

A. *Time*—Selects goal-relevant activities, ranks them, allocates time, and prepares and follows schedules
B. *Money*—Uses or prepares budgets, makes forecasts, keeps records, and makes adjustments to meet objectives
C. *Material and Facilities*—Acquires, stores, allocates, and uses materials or space efficiently
D. *Human Resources*—Assesses skills and distributes work accordingly, evaluates performance and provides feedback

Interpersonal: Works with others

A. *Participates as Member of a Team*—contributes to group effort
B. *Teaches Others New Skills*
C. *Serves Clients/Customers*—works to satisfy customers' expectations
D. *Exercises Leadership*—communicates ideas to justify position, persuades and convinces others, responsibly challenges existing procedures and policies
E. *Negotiates*—works toward agreements involving exchange of resources, resolves divergent interests
F. *Works with Diversity*—works well with men and women from diverse backgrounds

Information: Acquires and uses information

A. *Acquires and Evaluates Information*
B. *Organizes and Maintains Information*
C. *Interprets and Communicates Information*
D. *Uses Computers to Process Information*

Systems: Understands complex inter-relationships

A. *Understands Systems*—knows how social, organizational, and technological systems work and operates effectively with them
B. *Monitors and Corrects Performance*—distinguishes trends, predicts impacts on system operations, diagnoses deviations in systems' performance and corrects malfunctions
C. *Improves or Designs Systems*—suggests modifications to existing systems and develops new or alternative systems to improve performance

Technology: Works with a variety of technologies

A. *Selects Technology*—chooses procedures, tools or equipment including computers and related technologies
B. *Applies Technology to Task*—Understands overall intent and proper procedures for setup and operation of equipment
C. *Maintains and Troubleshoots Equipment*—Prevents, identifies, or solves problems with equipment, including computers and other technologies

Exhibit 2C: SCANS Report: Foundation Skills

Basic Skills:

A. *Reading*—locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
B. *Writing*—communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
C. *Arithmetic/Mathematics*—performs basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
D. *Listening*—receives, attends to, interprets, and responds to verbal messages and other cues
E. *Speaking*—organizes ideas and communicates orally

Thinking Skills:

A. *Creative Thinking*—generates new ideas
B. *Decision Making*—specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
C. *Problem Solving*—recognizes problems and devises and implements plan of action
D. *Seeing Things in the Mind's Eye*—organizes, and processes symbols, pictures, graphs, objects, and other information
E. *Knowing How to Learn*—uses efficient learning techniques to acquire and apply new knowledge and skills
F. *Reasoning*—discovers a rule or principle underlying the relationship between two or more objects and applies it in solving a problem

Personal Qualities:

A. *Responsibility*—exerts a high level of effort and perseveres towards goal attainment
B. *Self-Esteem*—believes in own self-worth and maintains a positive view of self
C. *Sociability*—demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
D. *Self-Management*—assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
E. *Integrity/Honesty*—chooses ethical courses of action

By 1997 the NSSB had identified 15 economic sectors for which skill standards were to be developed. Most of the sectors correspond to traditional industry categories, but three (e.g., business and administrative services) cut across multiple industries. The Board first awarded grants to voluntary partnerships in three sectors: wholesale and retail sales; manufacturing, installation, and repair; and business and administrative services. Phase II awards have or are being awarded in construction operations, communications, education and training services, financial services, and hospitality and tourism services. Each of the voluntary partnerships will develop national voluntary skill standards for their job grouping, and requirements for the basic certificates that will encompass the core skills common to that entire sector.

The NSSB is partnering with the U.S. Department of Education (Office of Vocational and Adult Education) and the National School-to-Work Office to implement the Building Linkages Project, described below.

EXAMPLE

Building Linkages Initiative - *a collaborative effort to create school-to-work systems, policies, and implementation guidelines among groups of states in several career clusters*

The Building Linkages Initiative is a collaborative effort between the U.S. Department of Education (Office of Vocational and Adult Education), the National School-to-Work Office, and the National Skill Standards Board. The purpose of the project is to create multistate consortia of industry, organized labor, and secondary and post secondary schools to explore ways to integrate academic and industry skill standards and develop career pathways. The initial Cooperative Agreements were established in 1996 with three multistate consortia. The original consortia addressed the industry areas of Manufacturing, Health Sciences, and Business Management.

The three consortia of states each identified broad career majors for secondary schools. The creation of these career majors can serve as models for individual states and for local level consortia. The career majors integrate academic knowledge and skills required for entrance into careers in the workforce and entry into higher education and training. With this information, the consortia are:

- Connecting career pathways to occupational clusters;
- Providing examples and protocol for integrating academic, technical, and workplace skills into curriculum;
- Providing models for involving stakeholders;
- Helping create skill certificates for the career majors;
- Providing models for developing portable credentials.

Recently, three additional grants have been awarded to create consortia and career cluster curriculum frameworks in:

1. *Audio Visual/Communications*
2. *Information Technology*
3. *Transportation, Distribution, Logistics*

The National Science Foundation (NSF) Systemic Reform, Teacher Enhancement, Education Materials and Advanced Technological Education (ATE) Programs - *assisting systems that educate people for technology-based work*

The National Science Foundation divisions of Educational System Reform (ESR), Elementary, Secondary, and Informal Education (ESIE), and Undergraduate Education (DUE) all have programs that support the development and strengthening of education-to-employment systems. In particular, the ATE program, created in the mid-1990s and administered jointly by ESIE and DUE, is intended specifically to help develop and improve advanced technological education system building and related projects at the national, regional, and local levels. Although the focus of the ATE program is on high school and two-year college education, some support is also given to related science and mathematics education in lower grades and to technological education at four-year colleges.

The ATE program is targeted especially toward preparing people for technician positions in high-performance workplaces utilizing advanced technologies. The program supports projects that focus on technological education, national or regional Centers of Excellence for Advanced Technological Education, and special projects to support technological education goals.

The ATE program awarded its first grants in 1994 to centers and projects around the country and in a variety of technological fields. Each year since then, the ATE program has awarded grants twice a year to additional national or regional centers and projects. To date, 11 centers and 170 projects have received awards. Centers typically have received awards of approximately $3 million for a three-year period. Project awards have varied in both award amounts and length of support time. Some projects and centers have received continuing awards as well.

Among the technological education fields being supported by the ATE program are biotechnology, computer technology, electronics, environmental technology, manufacturing, and engineering technology. Support is also given to programs that prepare students in the fundamental math, sciences, and technology competencies required for advanced technological education.

Centers funded by the ATE program may be national or regional in scope. Typically they focus on a particular industry or area of technology education. Centers must provide a wide range of support services to a large number of school systems, high schools and colleges, employers, government, and other organizations. Services include curriculum development and dissemination; conferencing and networking opportunities; teacher and faculty development; dissemination of best practices; outreach to new schools, communities, and organizations; and other supports to assist local and regional programs.

The program has played a very significant role in promoting career-focused education; using both industry skill standards and academic standards; and system development among educators, employers, and other stakeholders to prepare people for future education and work in advanced technological fields. A number of the programs described in the various sections here have received support from the NSF ATE Program.

State, Regional, or City Impetus

A number of states have developed statewide systems, or system development guidelines. In some cases, cities or substate regions have developed systemic approaches to education-to-employment.

The City of Baltimore

A model 4+2+2 system, developed by the Maryland State Department of Education, Baltimore City Public Schools, Greater Baltimore Committee, University of Maryland at Baltimore, and Baltimore City Community College

The system developed for the city of Baltimore to prepare people for advanced education or entry into the bioscience industry workforce is an excellent example of a coordinated approach to comprehensive planning and management by state and local government, education institutions, private industry, and the community with federal government assistance. In 1992, with a Tech Prep grant from the U.S. Department of Education, the Maryland State Department of Education collaborated with Baltimore City Public Schools, the Greater Baltimore Committee, the University of Maryland at Baltimore, Baltimore City Community College (BCCC), and the DACUM Resource Center at Dundalk Community College to develop and implement a unique 4+2+2 tech prep system. The 4+2+2 model includes four years of technical high school education and training, two years of community college, and the option of two more years of college to receive a baccalaureate degree. Postgraduate program also are available for students to continue with professional level education. (*See exhibit 2D.*)

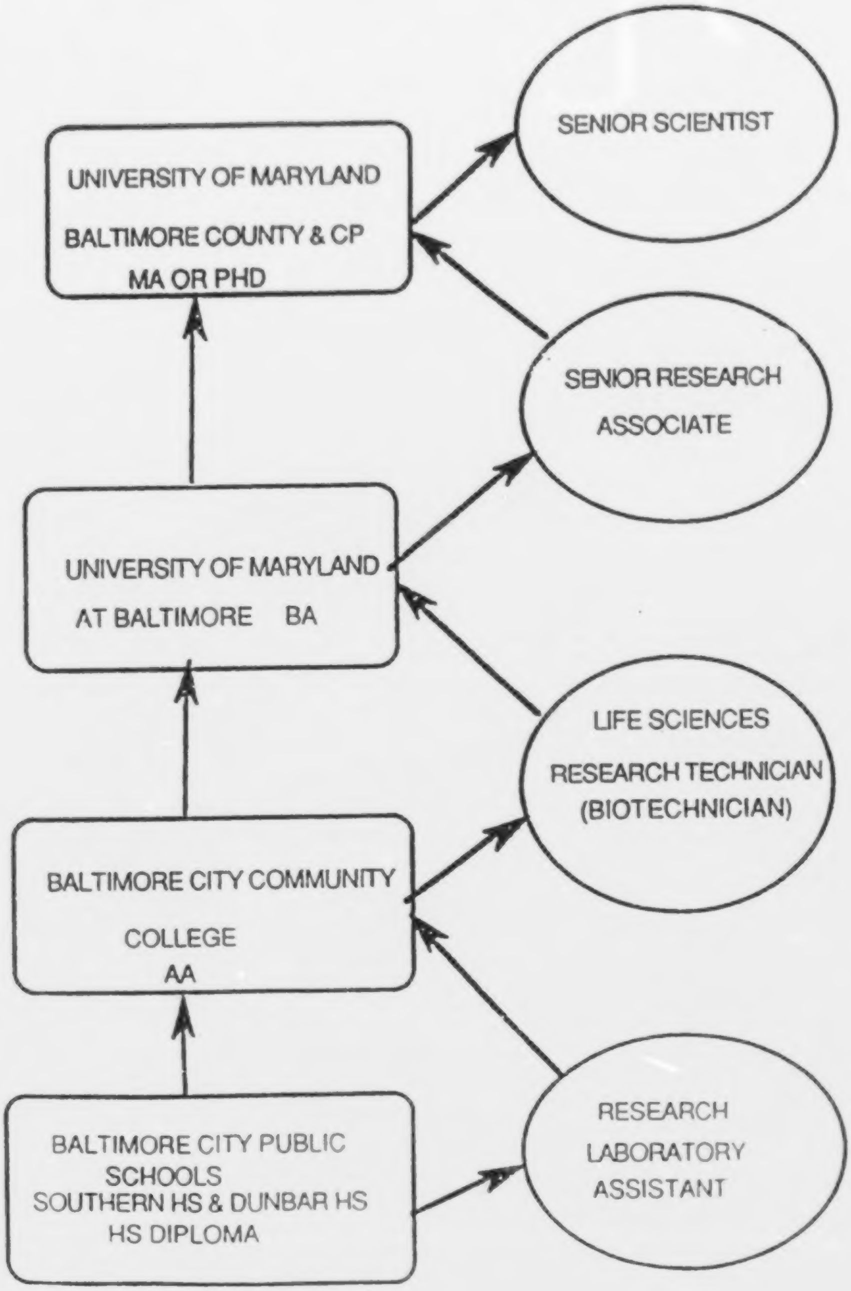
A Life Sciences Technical Committee, comprised of 16 area companies, was formed. The committee identified and clarified the future trends and direction for the life sciences field in Maryland. The group's report identified career ladders, job opportunities and availability, and training needs. The report aided planning for a series of programs, curriculum development, products, and activities. A DACUM job analysis process was conducted to establish competencies for the two clusters of occupations (research assistant and technician) identified by the Life Sciences panel.

A workshop was held in which secondary and postsecondary educators, and industry representatives used information from the Life Sciences study and the DACUM analysis to create a program overview, curriculum plan with course requirements, and a model articulation agreement between the Baltimore City Public Schools, BCCC, and the University of Maryland School of Medicine (UMSOM). This seamless curriculum was designed to fulfill Maryland's high school graduation requirements. The program is now operating in two Baltimore high schools (Southern High School and Dunbar High School), BCCC, and UMSOM. (*See separate examples of each program in Developing and Operating Programs section.*)

Students graduating from the Southern High School Biotechnology Academy or the program at Dunbar High School can earn credits at BCCC for certain courses taken in high school. They must meet the state's performance-based high school graduation requirements, including academic requirements, technical learning in one of the state's nine career clusters, and community service.

Associate degree recipients in the Biotechnology program at BCCC can

Exhibit 2D: A Continuum of Life Sciences Technician Training



CASE STUDY CONT.'D

transfer to the UMSOM Department of Medical and Research Technology to complete two additional years of college and earn a baccalaureate in either medical technology or biotechnology. The University of Maryland Chancellor's Office encourages students to continue through the last two years of college by offering $1,000 scholarships to eligible students.

Work-based learning is a part of the education of all students at every level of the system. Students in the programs in the high school, Baltimore City Community College, and UMSOM all participate in paid internships in Baltimore-area companies and public agencies and facilities of the University of Maryland Medical School in Baltimore. (*See exhibit 2E*)

The William Donald Schaefer Life Sciences Institute, located in the new Life Science building at Baltimore City Community College, provides life science education, training, and information services to the citizens of the Greater Baltimore area and to life sciences corporations in the area. Outreach projects to the community during the first two years have included a number of life sciences programs for K-12 teacher enhancement in science and mathematics, many programs for K-12 students, conferences for both science educators and heath-care professionals, and customized training programs for bioscience corporations. *(See program description in the Developing and Operating Programs section under Baltimore City Community College.)*

The Columbus Center for Marine Biotechnology, a publicly and privately financed research and education center, provides the biotechnology community of Baltimore with programs for everyone involved in the biotechnology education process. The center offers courses and internships for area high school students, advanced learning experiences and workforce training programs for college students, professional development for teachers, as well as conference facilities for seminars, workshops and conferences for the education, science, and technology communities of Baltimore.

EXAMPLE

Bio-Link - *a national Biotechnology Advanced Technological Education Center with 6 regional affiliates*

Bio-Link is a National Science Foundation funded Biotechnology Advanced Technological Education (ATE) Center. Funded in 1998, the Center enhances and expands biotechnology education programs by providing cutting edge professional development for instructors, improving curriculum, making use of technologies, and by setting up a system that promotes the sharing of information. Bio-Link is the only ATE National Center for Biotechnology in the country.

The National Center, led by City College of San Francisco, is located at the City College of San Francisco and works with 6 Regional Centers across the nation. Bio-Link works with baccalaureate institutions, high schools, national laboratories, and industry to accomplish a set of ambitious goals.

Exhibit 2E: Student-Trainee Employment Rating Report

EMPLOYMENT RATING
FOR: _______________________ DATE OF BIRTH ___/___/___ SOCIAL SECURITY # ____________

SCHOOL: _______________ LOCATED AT: _________________ GRADE: ______ PROGRAM______

NAME OF FIRM: ____________________________ ADDRESS: ____________________

JOB TITLE: ______________________________ CONTACT PERSON: ________________

TO THE EMPLOYER: The employment of the above-named student-trainee has been approved as part of his/her school program. Roster adjustments have been made at school to make possible this combination of schooling and work experience. Under this plan, a student-trainee may receive credit or fail in the work requirement just as a student may pass or fail in a classroom subject. This rating, therefore, is essential in determining the progress that has been made the job. Will you, or the person in charge of the above-named student-trainee, please indicate your rating of this person by filling in the form below. your evaluation should be based on a scale of 1 to 5 (1-lowest-5-highest). The statement after the numbers are only suggested interpretations. Please place check mark in front of number that best evaluates the trainee.

_______________	_______________	_______________
Date	Telephone Number	Counselor, Teacher-Coordinator

Completed form should be
returned to my attention at: ______________________________

1. Accuracy of Work

_____ 5. Consistently Accurate
_____ 4. Careful / makes few errors
_____ 3. Work usually passable
_____ 2. Work frequently must be redone
_____ 1. Careless/ makes many errors

2. Care of Working Area

_____ 5. Exceptionally clean and orderly
_____ 4. Very clean and tidy
_____ 3. Reasonably clean and orderly
_____ 2. Not very clean and tidy
_____ 1. Always untidy

3. Use of Equipment/Materials

_____ 5. Very careful and economical
_____ 4. Careful and economical
_____ 3. Exercises adquate care
_____ 2. Sometimes careless
_____ 1. Rough and wasteful

4. Speed in Performing Duties

_____ 5. Exceptionally fast
_____ 4. Fast
_____ 3. Adeuuate
_____ 2. Slow
_____ 1. Very slow

5. Use of Working Time

_____ 5. Busy and productive
_____ 4. Always busy
_____ 3. Usually keeps busy
_____ 2. Wastes time occasionally
_____ 1. Very Wasteful

6. Job Learning and Application

_____ 5. Exceptional ability
_____ 4. Learns with ease
_____ 3. Adequate
_____ 2. Learns with difficulty
_____ 1. Little or no learning

7. Reliability

_____ 5. Exceptionally dependable and conscientious
_____ 4. Dependable and conscientious
_____ 3. Usually dependable
_____ 2. Somewhat dependable
_____ 1. Unreliable

8. Initiative

_____ 5. Unusually self-motivated /creative
_____ 4. Needs little direction
_____ 3. Sometimes initiates
_____ 2. Waits for others to get started
_____ 1. Does not exhibit any

9. Attendance

_____ 5. Never absent
_____ 4. Rarely absent
_____ 3. Occasionally absent
_____ 2. Frequently absent
_____ 1. Always absent

10. Punctuality

_____ 5. Never late
_____ 4. Rarly late
_____ 3. Occasionally late
_____ 2. Frequently late
_____ 1. Always late

11. Attitude Toward Job and Training

_____ 5. Exceptionally interested and motivated
_____ 4. Interested and well motivated
_____ 3. Shows varied degree of motivation
_____ 2. Accepts training with reservations
_____ 1. Disinterested in job and training

12. Attitude Toward Co-workers

_____ 5. Excellent relationships
_____ 4. Works well with others
_____ 3. Gets along satisfactorily
_____ 2. Poor or no interaction
_____ 1. Does not get along

13. Attitude Toward Superiors

_____ 5. Very respectful/helpful
_____ 4. Cooperates willingly
_____ 3. Cooperates when asked
_____ 2. Poor cooperation
_____ 1. Disrespectful/resentful

14. Safety

_____ 5. Usually safety conscious
_____ 4. Safety Conscious
_____ 3. Takes average precaution
_____ 2. Often careless
_____ 1. Ignores safety rules

15. Personal Appearance

_____ 5. Exceptionally well groomed and in good taste
_____ 4. Neat, well groomed, and in good taste
_____ 3. Acceptable dress and grooming
_____ 2. Oftem untidy
_____ 1. Slovenly and or improperly dressed for job

16. General Estimate

_____ 5. Outsnding
_____ 4. Very Good
_____ 3. Good
_____ 2. Fair
_____ 1. Unsatisfactory

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ACTUAL NUMBER OF ABSENDCES FOR REPORTING PERIOD
____
ACTUAL NUMBER OF LATENESSES FOR REPORTING PERIOD
____

PLEASE USE REVERSE SIDE FOR ADDITIONAL COMMENTS REGAEDING SPECIFIC JOB SKILLS BASIC COMMUNICATION AND COMPUTATIONAL SKILLS, AND/OR OTHER GENERAL REMARKS
RATED BY : ____________________ FOR PERIOD FROM _______ TO _______, 19___
TITLE : ____________________ TELEPHONE NO. ____________________

There are six Regional Centers that affiliate with the national center, at City College of San Francisco. The Regions include the Northeast, Southeast, North Central, South Central, Northwest, and Southwest. Each region is developing relations with local industry and educational institutions and spearheading a specific element of the program.

Bio-Link has five goals:

1. Program improvement through the development and sharing of model programs and instructional materials
2. Instructor enhancement through professional development
3. Communication strengthening through the establishment of a national clearinghouse that promotes networking
4. New program assistance
5. School-to-Career awareness and implementation

Bio-Link plans to bring a wider range of underrepresented students to biotechnology who will have the knowledge and skills essential to the field as well as the ability to continue with more advanced education in math, science or engineering.

EXAMPLE

The New Hampshire Community Technical College System - *a statewide, two-year college system based on use of national industry skill standards and The Virtual Workplace*

The New Hampshire Community Technical College System brought together instructors from four of its two-year technical college programs to form a statewide Pedagogy Committee, which developed *A Pedagogy Blueprint for the 21st Century*. The blueprint bases curriculum, instructional strategy, and assessment in the four programs on their respective national industry skill standards. The four programs are Advanced Automotive Technology, Human Services, Electronic Systems Engineering Technology, and Biotechnology.

The curriculum of each of the programs has been redesigned to include the required skills, knowledge, and behavioral qualities of the industry skill standards. In addition, an emphasis on re-creating real work situations has led to the creation of *The Virtual Workplace* in each of the programs. In *The Virtual Workplace* classrooms are configured, equipped, and operated as real workplace settings. Students are expected to learn in a hands-on manner, by "doing" in addition to reading and conceptualizing. Students often work in teams, sharing knowledge and assisting each other. They collaborate to collect and analyze information to solve real work-based problems.

In each of the programs, local industry representatives have been heavily involved by

- giving lectures and sharing their training background;
- consulting to the instructors about curriculum content and other aspects of planning;
- assessing programs and students, and providing feedback to the instructors;
- providing access to equipment;
- keeping faculty current with industry methods;
- introducing students to people in industry settings.

The combination of a skill standards-based curriculum, instructional strategies that mirror the way work is done in real workplaces, and assessment methods that include performance-based measures and are tied directly to the content of the industry-determined skill standards, all help ensure that students in the four programs are well prepared to enter their respective industries upon graduation.

As a result of the collaborative development among faculty, and between educators and local industry

- collaboration across disciplines has grown;
- integration of technical and academic learning has increased;
- articulation between secondary and postsecondary education is growing;
- communication between college faculty and industry is stronger;
- instructors using skill standards-based teaching have a more concrete understanding of industry needs;
- *The Virtual Workplace* is being used more extensively (especially now that an internet version has been developed in the biotechnology program);
- the innovations begun in these four programs are becoming systemic, as support from the state Commissioner and other state education leaders has grown;
- increasing numbers of instructors are seeking information about the approach.

The program developers/instructors are all pleased with their new programs. State education data show that attrition rates in the four programs are significantly lower than in other programs in the system. However, the Pedagogy Committee offers a number of recommendations to enable their approach to grow and be sustained. Some of the recommendations are as follows:

- If their approach to performance-based learning is to be a system priority, the system needs to visibly support lead faculty practitioners more by providing additional dollars for equipment, local technical assistance, support staff, work study options, assessments, and tutors;
- Presidents and vice presidents of Academic Affairs need to provide more direct and visible support to faculty, and ensure that this support is recognized by the rest of the programs' campuses and by workers in industry;
- More funding for staff development is needed;
- Time must be set aside for lead faculty in this "virtual workplace" approach to give workshops to other faculty within the statewide system;
- Program skill standards should be integrated with general education;
- The system should implement employer assessment of *The Virtual Workplace* graduates compared with graduates of traditional lecture/lab programs to demonstrate the effectiveness of the "virtual workplace" approach.

EXAMPLE

State of North Carolina - *collaborative, statewide development of courses to introduce high school and community college students to careers in biotechnology and agriscience research*

The state of North Carolina is using the combined national bioscience and agricultural biotechnology skill standards to create a course that introduces secondary school students to career opportunities in the medical and agricultural biotechnology fields. The new course Biotechnology and Agriscience Research is being developed and will be taught at the junior and senior levels in high schools throughout North Carolina. This course is being created in response to the need of the growing agriculture and biotechnology industries within North Carolina. Many schools have created their own courses to respond to the needs of local employers. Yet, the creation of this new course will represent the first state-adopted course in this subject area.

Besides generating interest in these career fields and increasing understanding of the career opportunities, education officials in North Carolina hope to increase consumer awareness among students about all aspects of agriculture. A specific goal of this effort is to increase awareness and interest in agriculture among urban high school students, staff, and administrators, and to make them aware of aspects of agriculture such as laboratory research and animal care. The feedback frequently received by state instructional development staff from schools is that students are not interested in agriculture courses, yet interest in animal science courses in these schools is at an all time high. This high level is possibly due to an interest in pre-veterinarian course work.

An Advisory Committee was created that includes area biotechnology employers, staff of the North Carolina Biotechnology Center, and teachers. A staff person from North Carolina State University helps coordinate this effort by working with the Agricultural Extension Service. This committee has identified the national skill standards as the basis on which they wish to build their work. Having the national skill standards to react to and build their processes upon, saved the state significant time and resources. In addition, the national skill standards documents represent national agricultural and bioscience employer consensus with which the employers on the North Carolina Advisory Committee agreed.

The committee decided that the national skill standards were appropriate to form the basis for two levels of courses. The committee selected information from the standards that could constitute an introductory course and is currently working on developing this Level I course for high school juniors and seniors. The course will introduce students to the many career opportunities in biotechnology. The course blueprint contains four major components of study:

- Introduction to biotechnology and agriscience
- Basic lab and research skills
- Basic sciences
- Agricultural applications

After piloting the introductory Level I curriculum in North Carolina, it will be available through the National Council for Agricultural Education for use around the country. A Level II course may be developed at the community college level. The supplemental materials to the standards created by the national skill standards projects are being used as resources for an entire curriculum guide to be developed in conjunction with this effort.

EXAMPLE

BIOCOM - *a collaborative effort of executive leaders in industry, government, and education to assist the growing biomedical industry in southern California, including the preparation of a skilled, knowledgeable work force*

BIOCOM, located in San Diego, California, is a example of an unusually extensive coalition of public and private partners, working together toward a shared goal—regional support of industry growth and workforce development. BIOCOM was formed out of a merger between the Biomedical Industry Council and BIOCOM San Diego. It has increased ties with city and county agencies and is levering resources to meet the needs of biomedical companies in the area. Workforce development is an integral part of BIOCOM's agenda. In an effort to help create career opportunities in the biosciences, BIOCOM has instituted several workforce committees. One of these committees focuses on the education of a local workforce for manufacturing, a growing component of the region's bioscience industry.

This BIOCOM workforce committee is comprised of 35 members, including

- the biotechnology coordinator of the California Department of Trade and Commerce;
- the coordinator of the Governor's Biotechnology Advisory Council;
- the head of the California Employment Training Panel;
- the chair of the San Diego Workforce Partnership;
- key members of workforce organizations;
- local representatives of economic development councils;
- other industry members, including human resource directors, vice presidents of operations, and quality systems and regulatory affairs personnel (the companies represented include the Institute for Biotechnology Information, IDEC Pharmaceuticals, ISIS Pharmaceuticals, Advanced Tissue Sciences, Inc., and DURA Pharmaceuticals);
- Urban League of San Diego;
- CACT (Center for Applied Competitive Technologies).

The committee meets every five weeks and maintains an academic liaison body that comprises representatives from all local community colleges, four-year colleges, and universities.

The committee's focus is on the pre-baccalaureate employee preparation process. The national bioscience skill standards have been used as a basis for defining job roles in the area's bioscience industry and making recommendations to the local education institutions for programs and courses. The standards also have helped people reevaluate the importance of technical learning at both the community college and four-year college levels. During spring of 1998 the bioscience skill standards' relevance to local industry needs was assessed by the operations specialists on the committee. Their final recommendations were completed in the summer of 1998.

The committee's extensive and comprehensive activities include:

- enhancing existing research and development technician education programs;
- creating two vocational/technical education high school programs;
- creating two additional technician training programs (in chemistry and biology) at two local community colleges;
- creating a shared training facility that integrates education for local community college and four-year college students in applied, process-focused training activities;
- defining intern positions and placement of interested high school, community college, and university students;

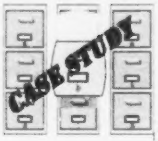
- overseeing a joint survey (conducted by the San Diego Regional Education Development Corporation and BIOCOM) that will provide data about the unique skill sets necessary for jobs and companies within the San Diego area.

BIOCOM has also collaborated with the San Diego Regional Economic Development Corporation, American Electronics Association, the San Diego Community College District, and several other electronics and telecommunications companies on the development of a survey that focuses on the need for qualified technicians in the electronics and telecommunications industry clusters. The survey includes questions regarding the need for technician-level personnel, any difficulties filling positions, the number of technicians in specific positions (e.g., electronics test technician, software test technician, design technician, CAD operator, process technician, drafter, etc.), how the company plans to increase or decrease these positions, what level of education is expected for the technicians, approximate salary for each position, and knowledge and skill areas common to the positions.

The committee focused on the baccalaureate-level preparation process, as well as training at the associate degree level in fall of 1998. New courses are available online at four-year colleges in San Diego. The courses are designed to produce bachelor-level graduates with a variety of new skill sets, allowing them to enter the industry trained in a process oriented, nonresearch track. Future plans for the committee include development of lower-level courses, to be shared between the community colleges and four-year colleges, as well as joint workshops.

Community-Based Impetus

Sometimes the leadership for developing an education-to-employment system comes from a community-based organization. CBOs, by themselves, usually cannot be the primary organizer of a community-wide school-to-career system. However, by working with local school and college systems and with support from local, state, and federal governments, museums, libraries, public education and training programs, and other types of community organizations can play a major role in catalyzing such a system and in providing community-based learning.



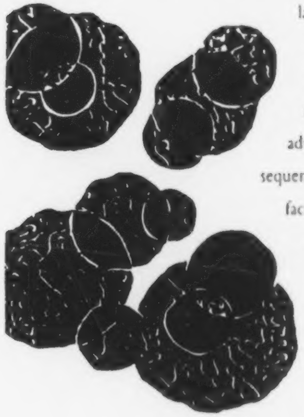
The Columbus Center

The Columbus Center's original focus was on education for middle and high school level students from urban areas. However, it has been developing relationships with a number of area community colleges, and is developing programs and internships for them.

The Columbus Center is an outstanding example of combining the practice of scientific research to support the local economy and providing a broad array of education and career exploration opportunities for a wide range of people in schools and the community. It also is an excellent example of a public-private partnership in which the public sector financed the development of the facility and the private sector donated the various technological equipment (microscopes, state-of-the-art laboratory equipment, computers and networking systems, video equipment and

Center of Marine Biotechnology

Already at work in Columbus Center is its scientific nucleus, the Center of Marine Biotechnology (COMB), one of four research components of the University of Maryland Biotechnology Institute. COMB is dedicated to fundamental and strategic research in biotechnology, molecular biology, and molecular genetics of the marine world. COMB's discoveries hold great promise for the development of powerful products and technologies that will improve the quality of our lives and the environment in which we exist. COMB's 173,000-square-foot state-of-the-art research laboratories and laboratory support functions include fish culture facilities, advanced molecular sequencing and synthesis facilities, and nuclear magnetic resonance instrumentation.



Hall of Exploration

The Hall of Exploration, designed by two-time Academy Award winner Bran Ferren, involves visitors in the excitement of scientific research. Exhibits based on actual research taking place in the Center's labs illustrate diverse aspects of marine biotechnology. In a three-story lighthouse, an interactive computer system guides visitors on a voyage through exhibits matched to individual interests. Visitor experiences include a 20-foot-long rockfish, a working waterfall, a walk-through cell, and a 40-seat horseshoe crab theater. Seven working laboratories, offering the opportunity to participate in authentic marine biotechnology research, surround the exhibition floor.

SciTEC

Columbus Center's Science and Technology Education Center (SciTEC) provides advanced hands-on science experiences to students, their families, and teachers who have been introduced to these concepts via the Hall of Exploration. SciTEC programs, taking place at Columbus Center and in the community, will help prepare the future workforce for science- and technology-related careers. SciTEC's facilities include an auditorium, wet laboratories, and a computer-assisted classroom. SciTEC will provide a new source of socially-relevant and scientifically-current multimedia programming for the international information highway and will also serve as a conference center for technology industries. Partnerships and programs with schools, churches, and community organizations support Columbus Center's outreach efforts. SciTEC's opening corresponds with the 1995/96 school year.

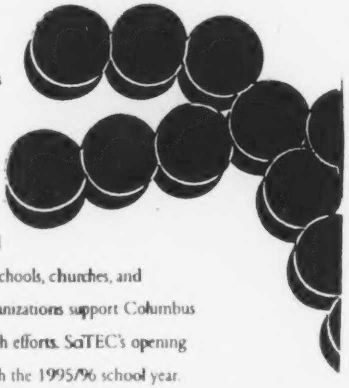


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Exhibit 2F: Columbus Center for Marine Biotechnology

systems, etc.) as well as some operating expenses. The center's mission was to join industry, government, the public school and community systems, and other facilities (such as area museums and the public library system) into a model communitywide learning system.

A public-private partnership that provides a variety of innovative learning opportunities for students, teachers, and the community in Maryland and neighboring states

The Columbus Center, located on the Inner Harbor in Baltimore, Maryland, is a $160-million facility, built primarily with grants from the city of Baltimore, the state of Maryland, and the federal government. The center was developed to (1) focus biotechnology research on the marine world; (2) improve public literacy in science and technology; and (3) help attract youth to careers in science, particularly groups currently underrepresented in the sciences. Christopher Columbus Development, Inc., a private, nonprofit corporation, not only developed, but owns and operates the center in partnership with the University of Maryland System.

The three original main components of the Columbus Center originally were (*See exhibit 2F.*):

- The Center of Marine Biotechnology
- Hall of Exploration
- Science and Technology Education Center

The Center of Marine Biology (COMB)

This center is the scientific nucleus of the Columbus Center, and one of four research components of the University of Maryland Biotechnology Institute (UMBI). COMB's mission is to conduct research that produces discoveries leading to new medicines and other commercial products, thereby creating companies and jobs for the region's economy. COMB employs more than 100 research scientists and technicians who work on commercially targeted research in biology, molecular biology, and molecular genetics of the marine world.

COMB scientists participate in state-of-the-art research, often in partnership with area companies and universities. COMB laboratories occupy the whole back third of the facility, and scientists often come in contact with people who come to the center to participate in education programs or visit the exhibits in the Hall of Exploration.

COMB provides summer employment and internships for area teachers in high schools and community colleges. Individual COMB scientists also supervise internships for students at Baltimore City Community College and high school students from the Southern High School Biotechnology Academy and Dunbar High School.

Hall of Exploration

Designed as the public attraction of the Columbus Center—the Hall of Exploration (now closed) contained a number of interactive exhibits about the many dimensions of marine biotechnology. Many of the exhibits allowed visitors to participate in hands-on experiments. Scientists and technicians from COMB, as well as teachers and students from some nearby school biotechnology programs, demonstrate marine biotechnology techniques, answer questions about the exhibits, and assist visitors in performing simple experiments.

Science and Technology Education Center (SciTEC)

This center was the primary educational component of the Columbus Center. The goal of SciTEC is to provide information about possible careers in the field of biotechnology and to provide a variety of education experiences for a wide spectrum of students, teachers, families, and community groups. These experiences range from introductory visits to advanced seminars. The center runs a series of laboratory-based programs in basic biotechnology techniques for which area schools may register. It will also design custom workshops and courses for students and teachers.

The facility is equipped with several wet laboratories where students conduct laboratory experiments, often taught by scientists and technicians from COMB. The center has a computer center with more than 40 computers, on which visitors can access programs, games, and information regarding biotechnology. The computers are also connected to the Internet.

In addition, the facility includes a large auditorium with video facilities. One program, called Meet the Scientist, has visitors view a short video showing an actual scientist or technician working in his or her laboratory on research in the COMB facility in the rear of the building. After the video, the real scientist enters the room and interacts with the audience, answering questions about his/her work, background, education, future plans, and other topics. The experience has proven to be educational and inspirational for young people, and in particular for those who might not have considered a bioscience career.

The SciTEC program has hosted hundreds of groups from schools, community programs, colleges, teacher education programs, churches, and other organizations from around Maryland and neighboring states. SciTEC provides advanced-level instruction to students and families, and professional development for teachers.

SciTEC also functions as a seminar center for the area technology industry and sponsors education and training conferences in partnership with the Maryland Department of Business and Economic Development, Maryland State Department of Education, and the University of Maryland at Baltimore. Professional development conferences and workshops are held regularly and newsletters and event notices are routinely distributed.

Private Sector Impetus

Sometimes the impetus for system development comes from a local corporation or a group of corporations. A great number of companies, in virtually all industries, contribute to education in a wide variety of ways. Many companies support general education, and specific technical education for their industry, by working with local schools and communities. Some examples of these partnerships are described in other sections.

Following are several examples in which companies have gone beyond the usual corporate commitments to education. These companies have taken on, as a major corporate goal, commitment to improving education in their community. In many cases, they focus particularly on education related to work in their own industry. However, they recognize that such education must include more than training only in technical skills. To carry out their commitment, these sample companies have not only participated with other stakeholders, but have taken the lead in developing collaborative systems with other community organizations. For this reason, we included them here.

Berkeley Biotechnology Education, Inc. (BBEI)

A fully developed industry, city, and community initiated, well functioning system in which all stakeholders work as partners

The creation of Berkeley Biotechnology Education, Inc. (BBEI), and its relationship with more than 40 biotech and healthcare companies, community leaders, educational institutions, local government, and individuals, is one of the unique and successful examples of system development and operation in the country. BBEI is an independent, private nonprofit organization, established in 1993 as part of an innovative 30-year agreement between Bayer Corporation and the city of Berkeley.

When Bayer wanted to transform its 30 acre facility in Berkeley into the company's worldwide center for biotechnology, they needed assurances from the city that the project could proceed with confidence over a long period of time, and they needed certain variances to the zoning in the mixed use area. In the course of a public process, Bayer and the city learned a lot about each other and about some shared problems and solutions. Bayer needed trained employees for positions as skilled technicians and the city and community was anxious for Bayer to hire Berkeley residents for these jobs. To satisfy the company's needs and the city's goals, an agreement was forged in which Bayer would provide a variety of contributions to the community. The major contribution was Bayer's willingness to spearhead and fund the establishment of a nonprofit organization that would establish a program to train low income residents of Berkeley to be prepared to apply for skilled positions in the biotechnology industry.

The company pledged a total of $1.4 million over a nine-year period to pay for the start-up costs and general operations of a yet-to-be founded nonprofit organization (established one year later as BBEI). The nonprofit organization would be responsible for program and curriculum development of a comprehensive high school and community college program, with an integrated work experience component, which would be implemented, initially, in Berkeley and benefit Berkeley youth. The funding was also

CASE STUDY CONT'D

intended to be used for teacher training and purchase of specialized equipment. In addition, the company pledged to provide paid summer internships for students in the high school program (the Biotech Academy at Berkeley High—11th and 12th grades) and paid co-op jobs for students who continue into the community college program (the Bioscience Career Institute at Laney College).and to assist BBEI in getting other companies interested in the program. In its agreement with the city of Berkeley, Bayer committed to hiring goals from the pool of graduates of the program, for its future laboratory and production technicians. [Independent of funds to BBEI for the high school and community college components, Bayer also committed $300,000 to develop a science mini-grant program for K-8 schools in Berkeley.]

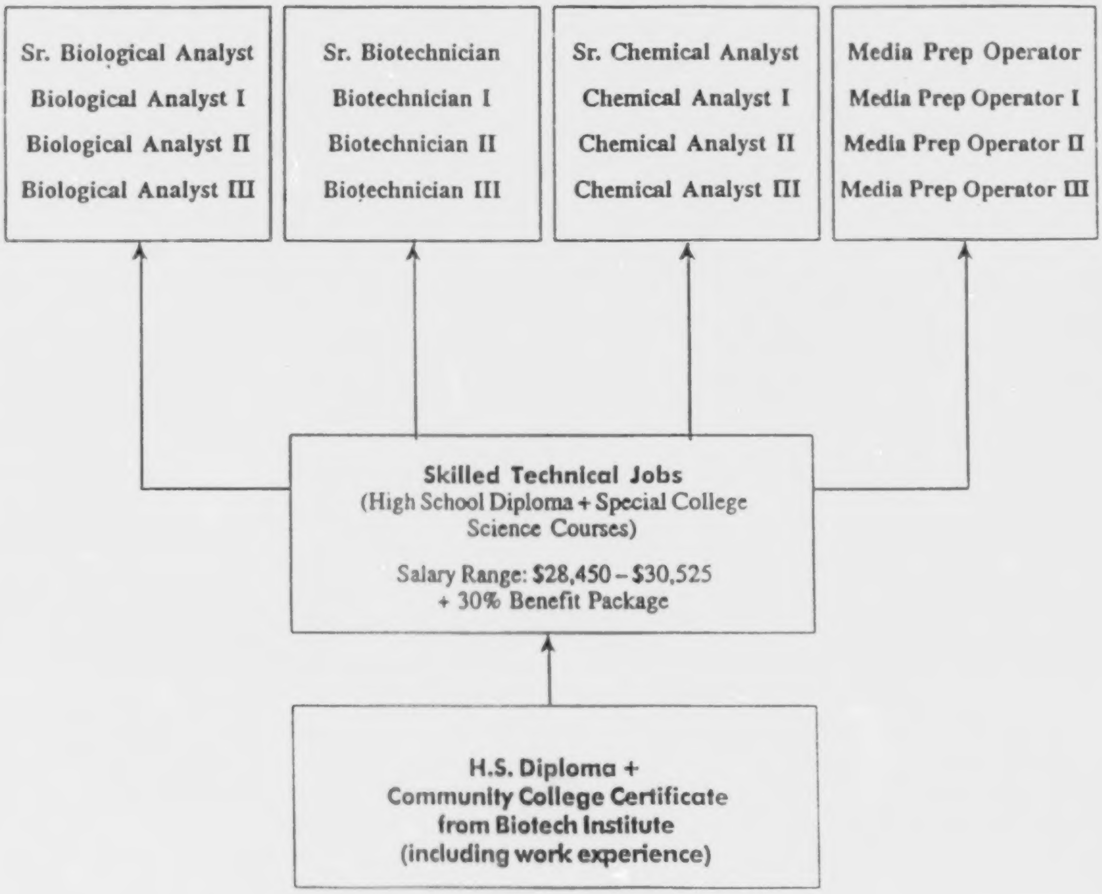
Beginning in 1995, BBEI began to raise additional funds from foundations, other biotech companies, government, and private donors. This new funding was used to enhance the program model and to expand to an additional high school.

Over the past 6 years, BBEI has shown that companies can participate effectively with schools: Company managers and workers play an active role advising the program; they work with teachers to develop and review curriculum to ensure it remains current and appropriate; they teach and visit science classes; they mentor and tutor students, and they participate in committees and in career awareness activities. Most important, they provide the paid work experiences students need in order to understand and value the classroom exercises as relevant. In Bayer's case, in addition to subsidizing the intern and co-op employees who work at the company through the program, Bayer has established a stipend fund for students who matriculate from the high school program to the community college program, and has donated equipment to the schools to enable them to implement the program appropriately.

About 35 employers are now working with BBEI—serving on the advisory committee, providing internships and co-op jobs, providing financial support and other resources, and hiring program graduates. BBEI's partners now include Bayer, Chiron Corporation, Baxter Healthcare Corporation, XOMA Corporation, Children's Hospital Oakland Research Institute, the U.S. Department of Agriculture, Lawrence Berkeley National Laboratories, and other companies, health clinics, and university and government research laboratories. Chiron has committed $200,000 over a 10 year period that will begin in the year 2000.

In 1996 BBEI selected Fremont High School in Oakland to be the replication site for the BBEI program that was piloted at Berkeley High two years earlier. Funding from private foundations was used to institute the expansion. Teachers and students from Berkeley High, as well as employees and administrators at BBEI's industry partners, have worked with Fremont to help build the program at the school.

Exhibit 2G: Employment Possibilities
(Completion of Specialized BBEI Courses in High School and Community College)



BBEI is governed by a 19-person board of directors, responsible for all fiscal decisions and policy directions. The board is comprised of residents of the communities in which BBEI functions and reflects the region's diversity and the professional arenas in which BBEI must function, including the biotech and healthcare industries. Student representatives sit on both the board and the advisory committee.

Currently, approximately 125 students are part of the BBEI program each year, and BBEI is looking at the possibility of expanding to other schools. With three groups of graduates completing the full three-year program, the organization can boast 100 percent successful placement of students in positions as skilled technicians, with salaries ranging between $22,000 and $34,000. All students who completed the program are still employed in the industry in positions with increasing responsibilities and commensurate salaries (*See exhibit 2G.*). Fifty percent of the graduates who are employed in industry are concurrently enrolled in programs to achieve their associates degrees.

BBEI has learned many important lessons and determined that several ingredients are necessary if a program is to be successful. They are:

- a strong partnership between industry as well as support from schools, the community, and government;
- a strong, continuing commitment of industry to support and participate in the program (over and above financial commitments and donations);
- the existence of an independently governed and financed organization (such as BBEI) with a paid and committed staff to manage the program and to ensure that the many components necessary for success work in the best interests of the students and industry;
- the integration of hands on academic learning and workplace experience through paid, relevant employment opportunities that integrate school and work;
- teaching methodologies appropriate for the students in the program;
- teacher understanding of industry requirements and expectations.

BioPharmaceutical Technology Center Institute (BTCI)

The BioPharmaceutical Technology Center Institute, located in Madison, Wisconsin, is a nonprofit, independent organization that was begun by Promega Corporation, a growing international biotechnology company, to educate people about biotechnology. BTCI is an outstanding example of what one company, in partnership with local schools, colleges, and other companies, can contribute to education.

CASE STUDY CONT.'D

Bill Linton, president and CEO of Promega explains his decision to commit extensive funding for BTCI:

> "As we think of our mission as a company, we recognize the customer base but we also know the importance of keeping up with the changes in technologies and markets. In other words, our employees have to be oriented toward education. BTCI is an example of long-term commitment. You have to look at it over many years and see how it makes a positive impact or has enhanced the creativity and involvement in the community on the part of our employees."

A nonprofit organization, established by a corporation to develop, coordinate, and operate a range of science and biotechnology education initiatives in Wisconsin

The primary goals for BTCI are to

- provide training in biotechnology and biopharmaceutical manufacturing;
- promote exchange of information among industry, educators, and the general public;
- support the development of high technology industries;
- provide science, technology, nature discovery, and arts programs for children and young adults;
- encourage greater understanding of the creative process;
- enable community organizations to offer educational and cultural programs.

Begun in 1993, BTCI has developed an expansive educational, scientific, and cultural program that facilitates biotechnology career exploration, training, and education. The institute is housed in the Biopharmaceutical Technology Center, built and owned by Promega. BTCI has access to the facilities of the center, including a 291-seat auditorium, meeting rooms, classrooms, a computer training center, and laboratories for biotechnology training and education. In addition to Promega, the center has received support from other companies, including Fisher Scientific, FOTODYNE Incorporated, NOVEX, Bio-Rad Laboratories, and VWR Scientific Products.

BTCI works in partnership with Madison Area Technical College (MATC) and the University of Wisconsin at Madison to develop and operate three programs to improve middle and high school level science education. With MATC, BTCI is also coordinating curriculum development and disseminating information for the Wisconsin Youth Apprenticeship Program in Biotechnology, a two year program for high school juniors and seniors. *(See Planning and Operating Programs section for more information.)*

EXAMPLE

Genentech, Inc. - *a company making major contributions to education at all levels in the San Francisco Bay Area*

Genentech, Inc., located in south San Francisco, takes their responsibility to the surrounding community very seriously. Many of the company's employees manifest this commitment by participating in Genentech-sponsored programs. The company maintains a list of employees who volunteer to be mentors to students in area schools during the academic year. The Genentech Foundation for Biomedical Sciences provides funds to Bay Area schools at all levels of education (from grade school through postgraduate).

One major program, the Gene Connection, a San Mateo County Biotechnology Education Partnership, was created in 1990 by three high school teachers with a grant from the Genentech Foundation for Biomedical Sciences and support from the San Mateo County Office of Education. Beginning with 3 teachers and 3 schools, the program, has now expanded to include more than 80 teachers in 22 schools. More than 20,000 students have been involved in the program in the last six years. Headquartered at Canada College in Redwood City, the Gene Connection program is administered by a steering committee which meets monthly. The program provides four different kits of equipment and supplies that are managed and distributed by two part-time biotechnology educators. The kits are transported to the schools by a van supplied and maintained by the Gene Connection program. These biotechnology educators provide teacher assistance and professional training through teacher workshops and conference presentations.

Another program that receives substantial support from Genentech is the San Francisco Biotechnology Alliance for Science Education (SF BASE). SF BASE provides experience in molecular genetics and biotechnology for all high school students in the San Francisco Unified School District. SF Base provides teachers with kits of equipment, expendable supplies, and all biological and chemical materials for a three-week unit on biotechnology. The program also promotes inquiry-based laboratory investigation, helps revise curriculum, and provides professional development for teachers.

- Genentech also assists two-year colleges in the Bay Area by
- providing representatives for advisory boards;
- teaching classes at the colleges;
- providing equipment and laboratory materials to the colleges;
- assisting teachers with curriculum development;
- providing paid, supervised summer internships for students.

Genentech maintains a corporate program as well, called Access Excellence. Founded in 1993, Access Excellence is a national educational program that provides high school biology teachers access to colleagues, scientists, and critical sources of new information via the World Wide Web. Funded solely by Genentech, Inc., the program was developed and launched with the assistance of many leading national scientific and educational organizations. *(See Enhancing Professional Development section for more information.)*

EXAMPLE

Southern California Edison and the Utility Workers Union of America, Local 246 - *labor and business working together to train non college-bound students as utilities workers*

A good example of significant labor involvement in school-to-work is the partnership between Southern California Edison and the Utility Workers of America, Local 246. In 1990 the Job Training-Skills Partnership Act Program (JTPA) sparked the interests of the utilities industry in working with noncollege-bound students. The Edison Company operates programs for engineering students, runs mentoring programs, offers scholarships for college-bound students, and participates in science fairs for grade school students. However, there has been no program for students who were not going to college. The idea of this new program was to train students for today's workplace, in which math and science skills and training play an enormous role. Skill standards developed for entry-level electronics workers were used to help design the training program. Since the program's beginning in the '90-'91 school year, 185 students have completed training.

The program faced a barrier at first, because company policy required all workers to be at least 18 years old. After Edison's training department convinced company executives of the program's merits, the legal department rewrote corporate policy to allow the company to hire 16-year-olds and to offer work-based learning to high school students.

The training department then met with the union's president, business agent, and unit chairman. It took only four hours for a joint labor-business group to draft the partnership agreement. The agreement was put to a vote and accepted.

Enthusiasm for the program was immediate. Nineteen mentors signed up at the first informational meeting with the bargaining unit. Upon hiring, student utility trainees became union members. Edison developed a job classification called "student utility trainee," and its three-tier wage structure was negotiated with the union. The starting wage is $6.00 an hour. After 150 hours, the rate moves up to $6.50. After 300 hours, the rate rises to $7.00. After that students are entitled to the same negotiated percentage wage increases as union members (e.g., an annual raise).

Before the end of the first year, the company and the union agreed to expand the program to two other locations. But the expansion created new challenges of consistency and accountability. In response to this, the company created the position of "job skills partnership administrator" and the union created a "educational program coordinator" position. These people oversaw the program at all sites and handled issues that cut across sites. Today the program continues to work, with dedicated people at all levels of labor and business.

3

How Can the System Be Organized and Managed to Ensure It Will Function Well, and Why Is a Third Party Essential?

Once the system has been developed and there is commitment from the partners, you need to manage the system to achieve the goals and maintain the partners' commitment. This is a daunting undertaking, often undervalued, and therefore underfunded and understaffed. The range of duties necessary to organize a system, keep it running smoothly, and expand and secure its members' commitment are presented in the following section. Included are case studies and examples of organizations referred to as third parties that manage the systems and meet the goals of its partners. Also described are the challenges the third parties are facing and the strategies they are using to meet them.

How Skill Standards Can Help

Skill standards can be used to define educational learning outcomes to meet industry and student needs. They can also be used to assess program achievement and provide guidelines to keep the work of the system focused. Additionally, they can provide benchmarks against which partners can measure progress. If the partners have agreed to the goals, based on the standards, and the system continues to move toward those goals, then the partners should remain satisfied and committed to working with the system. This continued commitment will enable the system to adjust to changing requirements and surmount barriers.

There are four primary "task areas" that system managers must perform to meet the needs of partners, to help make partners aware of the resources they offer, and to retain the commitment of partners to fulfill their shared goals.

- Networking
- Communication
- Accountability
- Continuing facilitation

Networking

The system managers must promote the organization and continually recruit important participants whose contributions will make the system work. Participants might include the mayors of local communities, city council members, Chamber of Commerce members, school board members, community college trustees, school system superintendents, local two- and four-year school deans, local union leaders, heads of community-based organizations, PTA chairpersons, heads of student groups, and others.

It is important to involve a wide range of stakeholders and ensure that they have input into the development of the system's goals and processes. To engage these participants and spread the word, managers might attend industry association and Chamber of Commerce meetings, city council and school committee meetings, and gatherings and meetings of schools, unions, community-based groups, and other organizations. All members of the original system can make use of their personal contacts to recruit additional members who will add value to the partnership. Use of the Internet and websites, organization newsletters, and other means of communication is very important for networking.

The system managers can stay in contact with managers and human resource directors at local workplaces to stay current with changing industry trends and the resulting personnel requirements. They can also form personal relationships with key people in local government, the school system, and other important stakeholders.

Most important, the system managers can be knowledgeable about the needs and the resources of various stakeholders to ensure that the system continually accommodates those needs and uses those resources.

Communication

Within the system, it is crucial that the managers maintain continual communication with all members. Regular briefings of all partners provide constant feedback about the goals of the system, the needs of each partner, and the resources each partner can bring to help realize its goals. Special forums can be held for local employers, educators, government, and others to inform them about the progress being made, and what roles they can play.

It is also important to gain an understanding of the different cultures of the various participant groups, and their special needs or constraints. For example, industry partners often prefer breakfast or lunch meetings to minimize disruption of their work day. However, teachers may need to meet in late afternoon or evening, after classes are over. Teachers may not have access to phones during business hours, so special arrangements may be needed to reach them.

Accountability

The system managers must remain accountable to the system members so all the partners feel that their efforts are worthwhile and that they can trust the others to perform their responsibilities. For example, if an employer gives equipment to schools, they should hear how educators are using that equipment in classes. Likewise, educators should receive feedback about how their program graduates are doing in the workplace.

Meetings for the working groups of the system should be well organized and task-oriented, with defined outcomes. Only people who are needed for a particular meeting should be invited. During meetings there should be open discussion by all participants of issues so that everyone is able to voice his/her viewpoint and become familiar with various stakeholder perspectives. This also helps build a sense of camaraderie.

The meetings should be tightly run and productive so that participants feel they are worth the time and effort taken from busy schedules. Commitments to carry out pieces of work by meeting participants should be noted and followed up on after the meeting.

In these ways the system managers can help ensure that the system participants remain committed to and active in the work of the system.

Continuing Facilitation: The Essential Role of a Third Party

In addition to keeping system members aware and involved, the system manager must act as a clearinghouse for educators, employers, and other stakeholders. This function includes, among other things,

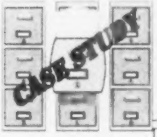
- informing partners about available resources for their needs;
- arranging for resources (materials, equipment) to be delivered to various schools from their sources;
- coordinating work-based learning for students and teachers in many different schools with a number of workplaces (this both protects employers from myriad requests from many schools and provides educators with coordinated information about various local work sites);
- linking area program graduates with various employment opportunities;

- notifying partners about opportunities to work together and assist each other;
- helping partners apply for grants and other assistance;
- keeping track of how the system is running, issues that arise, and the results of interventions.

Carrying out all these tasks is time-consuming. However well organized and dedicated, a single person (or even two people) cannot manage the system and perform full-time jobs. Likewise, parceling out these duties to a large number of people, who are busy with their own jobs, is not efficient and is unlikely to work.

Many people working in successful systems agree that the only way to have such a system work smoothly is to have one or more designated, paid-staff people, to fill the role of system manager and coordinator. The system manager could even be one or two teachers who are released from their teaching duties. Experienced people agree that most systems need one to two full-time staff to make it work.

Several examples of organizations that have been funded by a combination of public and private sources to act as the third party follow. Each organization uses some of its funding to support one or more system managers. In turn, these managers provide the networking, communication, accountability, and facilitation necessary to enable the individual institutions, without the resources and information, to accomplish their mutual goals—preparing people for future careers and/or higher education opportunities.



Northern California Biotechnology Center (NCBC)

Providing a great variety of useful services to San Francisco area community colleges and bioscience employers

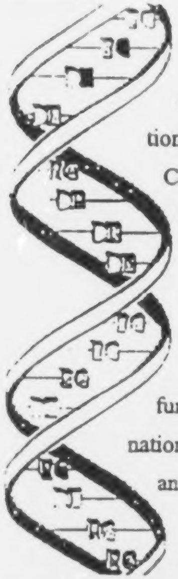
The Northern California Biotechnology Center, operating in the San Francisco Bay Area, is a partnership among Bay Area community colleges, biotechnology companies, and other area bioscience employers. The center's purpose is to facilitate collaboration and strengthen partnerships among the community colleges and the biotechnology industry of northern California (*See exhibit 2H.*) The center helps meet industry needs for skilled employees by helping the community colleges prepare students with the required skills and experience to qualify for entry-level positions. It also helps community colleges by identifying and linking up student and teacher internships and teaching resources in workplaces with area schools. The center is supported by the Chancellor's Office of the California Community Colleges.

The center's activities include providing an information clearinghouse of student internships with local employers, providing industry-expert guest lecturers to local classrooms, designing a community biotechnology education program through contract education with the community colleges and special projects with local businesses, enhancing student skill building for the biotechnology industry through a combination of short courses on specific

Exhibit 2H: Northern California Biotechnology Center (Objectives)

Who We Are

The Northern California Biotechnology Center is a joint project of Northern California community colleges which are dedicated to supporting the development of biotechnology.



Through a variety of special projects, public relations activities, workshops, publications, and research activities, the Center helps college faculty understand the educational needs of the biotechnology industry and encourages them to respond to those needs.

One of the Center's primary functions is to streamline coordination between biotechnology firms and community colleges. This includes arranging for student and faculty internships, equipment donations, and program development.

By serving as a liaison, the Center is able to leverage resources that help increase the quality of education for biotechnology students, as well as support the growth and development of Northern California firms engaged in biotechnology research and production.

Sample Projects

- *Creating student internships*
- *Facilitating faculty development*
- *Educating the community about biotechnology*
- *Bringing industry experts into the classroom*
- *Serving the educational needs of biotechnology firms*

Industry-Education Forum

A unique Industry-Education Forum serves the role of an advisory committee to the Northern California Biotechnology Center. The Forum helps mobilize educators and industry representatives to respond to problems and to collaborate on projects that are mutually beneficial. Projects may include research gathering, arranging of community meetings, assisting with specific needs of biotechnology firms in Northern California, and more.

Who Benefits?

Biotechnology CEO's, human resource directors, students and educators are invited to use the Center as a source of information, industry-education links, training activities, and problem solving.

There is no cost to use the Center's services.

Northern California Biotechnology Center, 1998

CITY COLLEGE OF SAN FRANCISCO

Exhibit 2I: Northern California Biotechnology Center Internship Objectives

Intern: ______________________ **Date:** ______________________

Your objectives each semester should be for new or expanded responsibilities. For example, if you do routine office work of keyboarding, copying and filing, then your objective should be something new you want to learn, such as creating an organizational chart, managing a mailing list, or working with a new computer program. Write three objectives and show them to your employment supervisor and cooperative education instructor. Be willing to rewrite your objectives after your supervisor and instructor see them. Remember to make your objectives measurable.

1a. What task will you complete?

1b. How will you accomplish it?

1c. How will it be measured/evaluated and by whom?

1d. When will you complete it?

2a. What task will you complete?

2b. How will you accomplish it?

2c. How will it be measured/evaluated and by whom?

2d. When will you complete it?

3a What task will you complete?

3b How will you accomplish it?

3c How will it be measured/evaluated and by whom?

3d When will you complete it?

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CASE STUDY CONT'D

topics and overall curriculum review and revision activities (e.g., in March 1998, 13 faculty members from nine community colleges met to discuss ways to revise their curriculum to meet the expressed needs of the industry), and maintaining an Industry Education Forum.

The Industry Education Forum serves as an advisory committee to NCBC. The forum facilitates collaboration among educators and industry representatives on finding mutually beneficial solutions to common problems they identify. Forum projects include gathering information about specific current needs of the industry, suggesting how community college students can compete for entry-level jobs, tracking current trends in the biotechnology industry, and assisting biotechnology firms in northern California with their specific needs.

NCBC provides standardized guidelines for all area schools, student internships, and employers, as well as methods for intern evaluation. It also provides an internship start-up kit that includes

- an internship announcement that a Bay Area company sends to NCBC;
- student application and referral forms;
- internship objectives, such as guidelines and sample objectives (*see exhibit 2I*);
- an internship program agreement;
- an attendance timetable;
- student self-evaluations;
- employer evaluation forms (*see exhibit 2J*);
- student fact sheets;
- student skills information sheet.

The center invites biotechnology industry personnel, human resource directors, students, and educators to use it as a resource for providing information, establishing industry-education links, training activities, and problem solving. The center also arranges for faculty internships, equipment donations to schools by employers, and program development in area schools. The center both leverages resources to increase the quality of education for biotechnology students and supports the growth and development of northern California biotechnology research and production.

The center develops curriculum and provides various support services to area community colleges to prepare people for work in the rapidly expanding biotechnology and agricultural biotechnology industry in central California. They identify and develop models for biotechnology education, student support services, and recruitment and retention programs targeting underrepresented student populations.

Exhibit 2J: Northern California Biotechnology Center Employer Evaluation

TO BE COMPLETED AT THE END OF THE TERM BY THE EMPLOYER

Name of Intern/Employee: ______________________________

Address: ______________________________ Phone: ______________

Period of applicable employment: from ______________ to ______________

TO THE EMPLOYER: This is a rating sheet for the above-named student who is employed with your company and enrolled in the CCSF work-based learning program. The student and the City College advisor/coordinator will discuss the contents, and this rating will be used in the evaluation of the internship.

	Not Observed	Excellent	Good	Satis-factory	Poor	Inadequate
JUDGMENT						
INITIATIVE						
COOPERATION						
DEPENDABILITY						
PUNCTUALITY						
COMPETENCE						
PROMOTION POTENTIAL						
ABILITY TO LEARN						
APPEARANCE						

Comments:

____
Supervisor's Signature Date

Southern California Biotechnology Center (SCBC)

Promoting collaboration among and serving the needs of industry and community colleges in southern California

The Southern California Biotechnology Center, located at MiraCosta College in Oceanside, California, was established to serve the employment and educational needs of the biotechnology community of southern California. The center is funded by the State Chancellor's Office of the California Community Colleges. It is one of four currently operating California centers in the biotechnology field. (Eventually there will be six operating in various areas of the state.) SCBC is managed by the director of MiraCosta College's biotechnology program and another biotechnology instructor.

The purpose of SCBC is to provide biotechnology and related industries a direct link to the community colleges, as well as to coordinate activities and services among colleges, employers, high schools, and government to meet the needs of the biotechnology industry. Services are provided free of charge in the three main areas: Education and Training, Communication, and Materials and Resources. Workshops on these topic areas are held at the local two-year colleges, including MiraCosta, San Diego City College/CACT, Miramar, Palomar, Irvine Valley, and other sites. One example of a workshop held for science instructors was a free, four-day session held in June 1997 that provided an opportunity for community college and secondary school science faculty to increase their laboratory skills in biotechnology. Another example is a one-day Internet access workshop devoted to training users on an electronic database related to biotechnology.

A Materials Resource Center is also available to help facilitate industry support of educational programs. The purpose of the specialized resource center is to act as a broker, receiving donations of equipment and supplies from employers and making them available to secondary and community college instructional programs in the southern California region. Donations include dated equipment which is in operational order, equipment with minor or reparable defects, or materials and reagants no longer in retail or manufacturing use. SCBC has hired an industry technician to deliver equipment and materials to area schools.

SCBC publishes a newsletter and maintains a website, both of which provide information about biotechnology-related curriculum, workshops, resources, and career opportunities in southern California. SCBC is an excellent resource for teachers at community colleges and secondary schools for free information, training, and materials.

Bay Area Biotechnology Education Consortium (BABEC)

An active coalition of six regional networks, helping high schools and teachers develop exciting programs in bioscience, and developing novel linkages with area employers

The Bay Area Biotechnology Education Consortium, located in San Francisco, has developed a system to resolve issues on behalf of regional bioscience educators and employers. BABEC is a nonprofit organization, created with a grant from the Genentech Foundation. BABEC's purpose is to

- develop hands-on high school biotechnology activities based on a ground-up BABEC model of curriculum development. (The ground-up approach focuses on the concept that the classroom is where students' interests get sparked. The teacher has the ability to engage all students in science, including those who may not be favorably disposed to science. BABEC seeks to find the spark that excites students and then build curriculum around that spark, while harmonizing with the skill standards.);
- implement and sustain these contemporary laboratory-based curricula by providing teachers with free access to skill training , equipment, and materials necessary for these curricula;
- assess the impact of these curricula in the classroom, measuring both attitudinal and content changes. (BABEC is currently testing some assessment techniques that carefully measure biotechnology education outcomes.);
- develop novel fiscal mechanisms (such as licensing curriculum, licensing logos, and contract work) for bringing the entire program to fiscal sustainability with no need for further grant money in five years.

BABEC is a regional outgrowth of six preexisting, largely volunteer networks which have been implementing systemic change in science teaching by providing training, equipment, and in-class support to teachers. Together, these networks develop laboratory experiment kits for circulation among area schools. The kits are delivered to the schools, where they may use them for six to eight weeks. The six networks are as follows:

- SF-BASE—San Francisco Biotechnology Alliance for Science Education
- Gene Connection (G*C)—San Mateo County Biotechnology Education Partnership
- SCCBEP—Santa Clara County Biotechnology Education Partnership
- EBBEP—East Bay Biotechnology Education Partnership
- PROBE—Program for Biotechnology Education in Marin County

CASE STUDY CONT.'D

- CISBE—Consortium of Independent Schools for Biotechnology Education

BABEC has built upon this network and added new dimensions in the areas of materials management, curriculum development, fiscal management, and assessment.

One unique example of how BABEC has sustained curriculum development efforts is the agreement between BABEC and Bio-Rad Laboratories (Hercules, California) to license a new piece of biotechnology curriculum developed and field tested by BABEC. In the agreement Bio-Rad sells the kit of the activity developed, *Secrets of the Rain Forest*, and advertises it on the Web, giving BABEC of some the generated revenues.

This Bio-Rad partnership arrangement is one example of how BABEC supports their advancement of educational goals for both students and faculty of biotechnology education. By creating such partnerships with industry, teachers can streamline curriculum development and implementation in a cost-effective manner. High technology education is generally considered expensive and difficult to implement. BABEC is breaking fresh ground in finding ways to make biotechnology education accessible to every high school student, thereby creating models which can be replicated by other groups nationwide.

EXAMPLE

Ventura College/Center for Applied Biological Technologies - *providing support to community colleges, the biotechnology industry , and other related organizations in central California*

Ventura College, in the Los Angeles area, has offered a program for several years to prepare people for work in local bioscience companies, such as Amgen and Monsanto. The college recently began a two-year curriculum in plant biotechnology to respond to the growing needs of the area's agricultural industry.

The program uses the information about required skills, knowledge, and behavioral attributes from the national bioscience and agricultural biotechnology skill standards to develop the curriculum. The college also uses the scenarios from the bioscience industry skill standards in conjunction with Food and Drug Administration regulations to help make these FDA regulations "come alive."

The college recently received funding from the Chancellor's Office of California Community Colleges to be the locus of the Center for Applied Biological Technologies for the central California area. The center serves a 12-county area, including seven community colleges, public and private sector agencies, biotechnology companies, and other biotechnology projects. It develops curriculum and provides various support services to area community colleges to prepare people for work in the rapidly expanding biotechnology and agricultural biotechnology industry in central California. The center identifies and develops models for biotechnology education, student support services, and recruitment and retention programs, targeting underrepresented student populations.

The center works to strengthen the California Biotechnology Education Consortium (CBEC) and coordinates with the other two existing regional biotechnology centers (Northern and Southern California Biotechnology Centers). Eventually there will be six such centers in California for the biotechnology industry.

Greater Baltimore Advanced Technology Center (GBATC) - *a broad, comprehensive, active coalition that links economic development, seven region industries, and eight community colleges , and uses innovative methods to help serve all of their needs*

The Greater Baltimore Advanced Technology Center is a comprehensive and extensive partnership among state and local economic development agencies, eight Baltimore-area community colleges, and representatives from industry created to serve emerging and expanding advanced technology companies. Part of this assistance involves developing and supporting education for these industries. The GBATC serves as a liaison between the local colleges and the economic entities by providing services that link them together. Seven areas of advanced technology are targeted: financial services, health care, biotechnology, distribution and logistics, information technology, technology-driven manufacturing, and telecommunications. The purpose of GBATC is to leverage resources to provide rapid and customized training and technical assistance to the targeted industries by using state-of-the-art equipment, promoting instructional excellence, and providing technical expertise.

By collaborating in the use of resources and offering a unified voice, the GBATC supports the region's business recruitment efforts and serves as an initial contact point for economic development officials, the Greater Baltimore Alliance (GBA), and other organizations that bring technology-based business to Maryland. The center also manages the seven industry sector "affinity groups," which include college, economic development, business, and industry representatives. The affinity groups identify training needs of the employers, create/revise curricula, develop/maintain state-of-the-art facilities, and facilitate industry interaction on a regular basis. The affinity groups present their information and updates through a virtual catalog. Materials produced are available online and in hard copy. The virtual catalogue is also used for training that can cross industry boundaries.

The community colleges and Baltimore City Public Schools promote the sharing of faculty, facilities, and other resources in an effort to reduce costs and avoid duplicate training and services. Students must receive a grade of C or better in an approved course to meet articulation requirements between the high schools and community colleges. Tech Prep Scholarships are also offered to applicants who major in biotechnology, business technology, child care, or electronics technology; have a B or better grade-point average; have graduated from a Baltimore City Public School; and are accepted as full-time students at one of the community colleges.

MassJobs Council School-to-Work Task Force - *helping educators, employers, and other stakeholders develop local school-to-work partnerships and make use of industry skill standards*

The state of Massachusetts' MassJobs Council School-to-Work Task Force developed a set of materials for education systems, employers, and other stakeholders to create and maintain local area partnerships for implementing school-to-work. These materials contain comprehensive information for industry associations and employers designed to inform them about STW, the needs of STW systems for industry involvement, and the benefits of these efforts for employers, including:

- An introduction for employers to the School-to-Work Initiative—which describes the goals of STW, the components of a STW system, information about the Massachusetts economy and how STW could have an impact on it, and ways that employers could become involved in STW in their local areas;
- A handbook for employers (written for the CEO)—which provides information about how to become involved in STW, the role of the employer in the process, specific tasks, recommendations, and materials for employees, strategies for maximizing long-term effects, and model case studies;
- A pamphlet, "The Role of Industry Associations in Building a School-to-Work System"—with information on how to learn more about STW and how it can benefit industries, and action strategies to inform members and involve them in STW efforts;
- A description of the organizations in Massachusetts—the Associated Industries of Massachusetts (AIM) and the Regional Employment Boards (REBS)—that serve as information sources, recruiters, and "brokers" to inform and help link employers with local partnerships;
- A list of Massachusetts industry associations and businesses that are participating in school-to-work efforts in the state;
- Information about the availability of skill standards for various industries, as the standards are developed.

This entire set of materials helped facilitate the process of involving employers with education institutions and other stakeholders in local STW partnerships, and use of industry skill standards in system development.

The council has sponsored several statewide conferences, featuring experts in various aspects of STW and use of skill standards. It continues to help develop and maintain local partnerships, and assist them in networking among themselves, and with other organizations.

EXAMPLE

NorthMontCo Technical Career Center (NMTCC) - *a collaborative STW planning effort in Pennsylvania, based on industry skill standards and lessons learned from initiatives in other states*

The NorthMontCo Technical Career Center (NMTCC), located in the Philadelphia area, has recently begun a biotechnician training program that prepares individuals for entry-level positions in the biopharmaceutical industry. NMTCC currently directs vocational-technical programs within the Montgomery County, Pennsylvania, area. The program received initial guidance from the School-to-Work office in the Bioprocessing Resource Center, Inc. (BRC), located in State College, Pennsylvania, which was supported by a federal grant.

The NorthMontCo project began with initial discussions between the STW coordinator and educators about how to use the national bioscience industry skill standards, developed by Education Development Center, Inc., in their biotechnician technical training program. NMTCC decided to further investigate the creation of a STW program for biotechnicians and procured a development grant from the Pennsylvania Department of Vocational Education to proceed.

A partnership was developed between NMTCC, local high schools, and postsecondary programs. The partners visited technical training programs in Massachusetts, New Hampshire, and Maryland to learn about various models of STW systems and how these were dealing with various issues. The partnership then held a summit meeting, attended by 70 people representing industry and education. Guest speakers included graduates of technical programs who described their careers in industry; directors of technical training programs in other regions who described their programs; and human resource representatives from industry, who described their experiences hiring graduates of technical training programs.

A steering committee was formed, with educators and industry representatives. The steering committee has (a) surveyed guidance counselors in high schools, (b) surveyed high school students to determine interest in the program, (c) conducted worker profiles, (d) developed job-profiles by means of face-to-face surveys (*see exhibit 2K*), and (e) conducted a labor market survey. It has appointed three committees thus far—facilities, curriculum, and funding. The steering committee has also conducted a Work Keys profile and a biotechnician job profile to confirm what skills are needed for an entry-level biotechnician in this field. The definition of a biotechnician, as well as the technical, academic, and employability skills used in developing these documents, were taken originally from the national bioscience industry skill standards.

Once the NorthMontCo program has been fully established, curriculum based on the standards and local information will be developed for the high school and community college levels, culminating in an associate degree. Technical training will occur at NMTCC, while other required courses for the degree will be offered at local postsecondary institutions that will have articulation agreements with NMTCC.

4

How Can Support Be Obtained for the System?

Developing and maintaining an extensive education-to-employment system, such as the ones presented here, requires substantial funding. Virtually all of the systems described have obtained support from numerous sources. Although this can be a daunting job for an understaffed organization, fortunately there are a great number of funding sources for education-to-employment.

One purpose of a broad-based system of partners for education-to-employment is to help access funding for developing and maintaining the system. These partners can also help obtain support for program and curriculum development, teacher development, equipment and materials, and other costs of preparing people to meet industry and further education requirements.

This section offers information in the form of lists and brief examples, of sources and ways that coalitions have obtained support, rather than examples and case studies. Some of these sources and methods are quite creative. The names of organizations that have used and suggested many of the sources and strategies are provided. As in all cases, the information here is not exhaustive, and other sources and strategies can be added. However, this information is helpful for those just beginning to develop systems or needing fresh ideas.

How Skill Standards Can Help

Funders are interested in supporting endeavors that seem to have a good chance of achieving their stated results. The skill standards help clearly define the learning outcomes the system plans to achieve. These learning outcomes meet the goals of many federal programs, as well

Exhibit 2K: Job Profiling Survey (sample page)

Technical Skill	Importance of Skill			Training / experience		
Description	Critical	Useful/ Helpful	NA	Little training/ Little experience	More training and little experience	More training and more experience
Maintain inventory and supplies.						
Prepare solutions – • media for cell culture, • buffers for purification, • reading protocols/recipes.						
Use of common lab equipment • electronic digital scales • centrifuges • spectrophotometer						
Select and appropriately use other lab tools such as pipettes and graduated cylinders.						
Sterilizing; autoclaving; transferring solutions without contamination.						
Document results according to GLPs and cGMPs.						
Maintain cells in culture includes • monitoring growth, • monitoring media, • changing media, • passing cells, • aseptic techniques, • preparing and reading microscope slides.						
Maintain bacterial cultures using standard microbiological techniques. Includes: • streaking plates for an isolated colony • inoculation of flask cultures • monitoring growth						

as state and local education and economic development agencies. They also meet the needs of corporations and other potential private sector funding sources. Coupled with a well-developed plan for reaching the system's goals, the standards make clear the returns that funders can expect for business and the public.

Sources of Grants, Contracts, Contributions, and Other Support

Public Sector: Federal Government

U.S. Department of Education (DoEd), Office of Vocational and Adult Education (OVAE): Tech Prep funding has been used by many state and local coalitions (e.g., the city of Baltimore).

DoEd Fund for the Improvement of Post Secondary Education Program (FIPSE): Provided a grant to the New Hampshire State Department of Technical Education to develop the statewide technical education system described in this manual.

U.S. Department of Labor (DOL), Employment and Training Administration: Funding for JTPA, Workforce Investment Act (WIA), and other targeted programs can be used to help serve eligible populations (BBEI has used JTPA funds to pay students for internships).

U.S. Department of Labor: Funding for dislocated defense workers has been used by San Diego State College to retrain people in their programs; Minuteman Vocational Technical School in Massachusetts has used this funding to retrain dislocated workers for work in the computer industry.

U.S. Department of Energy: Lawrence Berkeley Laboratory has received grants to educate community college students in research techniques by pairing them with practicing scientists and providing summer workshops for them.

National School-to-Work Office (NSTWO): Most state governments have received large grants to develop statewide school-to-work systems; states are required to allocate most of these funds to local or regional coalitions. Some communities have also received STW grants from the national office; in some cases the Federal Work Opportunity Tax Credit may apply to STW *(see "The Work Opportunities Tax Credit Program and School-to-Work" on the STW Learning Center website, Appendix B).*

National Science Foundation (NSF) Advanced Technological Education (ATE) Program: A number of the programs described in this manual are funded by NSF ATE grants that support programs linking community colleges and high schools with other stakeholders to prepare people for work in advanced technological careers.

Public Sector: State Governments

California: Grants tax credits to companies that hire graduates of local technical education programs who meet certain profiles (e.g., income level, ethnicity).

California State Chancellor's Office for Community Colleges: Provides funds for regional technical centers in various industries and in various areas of the state; the chancellor's office also provides support for programs at community colleges around the state.

Colorado: Provides a 10 percent tax credit for direct costs that an employer incurs by hiring a student enrolled in a STC program.

Maryland state government: Has an Employer Incentive Fund, available to groups or consortia of employers, labor organizations, and trade associations who create work-based learning opportunities in state-targeted industries or cluster areas, with preference for groups offering matching funds.

Massachusetts state legislature: Provides support funds for industry-technical training alliances to develop programs to prepare people for work in certain industries.The North Carolina state government is providing funding to develop a statewide high school curriculum in bioscience, based on the bioscience and agricultural biotechnology skill standards.

North Carolina state government: Provides funding to develop a statewide high school curriculum in bioscience, based on the bioscience and agricultural biotechnology skill standards.

Pennsylvania state legislature: Provides extensive funding for customized job training (CJT) to private companies; school systems and colleges that partner with those companies can receive some of that funding from their business partners to develop and operate programs; the state is also considering a Student Apprenticeship Opportunity Tax Credit Act.

University of Maryland Chancellor's Office: Encourages eligible graduates of the state's community colleges to continue their education at four-year colleges by providing them with $1,000 scholarships.

Public Sector: Local Sources

Some local school systems, individual schools, and community colleges use local funds, school-to-work grants, or other sources of funding earmarked for teacher professional development or other activities to pay teachers to visit local industry workplaces and/or develop a program and curriculum, direct a program at the school, and act as a liaison to other schools, employers, and government.

The Berkeley, California Police Department: Donates money confiscated from illegal transactions to the BBEI program. The money funds student internships in companies and pays for small rewards (such as free movie tickets) to students who excel in their studies.

Private Sector: Companies and Corporate Foundations

A large number of companies and corporate foundations provide extensive funding to individual schools and colleges or consortia of schools to develop and operate education-to-employment programs and systems, or to pay student and teacher interns. Among these are the Woodrow Wilson scholarships for summer scholars at Princeton University, the internships listed by Access Excellence (operated by Genentech), the Spencer Foundation, the Danforth Foundation, and others that can be identified in foundation directories.

Many companies provide equipment, supplies, and in-kind contributions, such as time of managers, workers on advisory boards, work with program and curriculum developers, development of skill standards as a basis for programs and curriculum, professional development for teachers, company tours and career information days, teaching classes or courses, supervising student and teacher interns, and providing service and repair of equipment.

In one arrangement, Bio-Rad Laboratories, in the San Francisco Bay Area, signed an agreement with the Bay Area Biotechnology Education Consortium (BABEC) to license a new piece of biotechnology curriculum developed and field tested by an education partnership, including Bio-Rad and several community colleges in Santa Clara County (members of BABEC). The activity developed, *Secrets of the Rain Forest*, allows Bio-Rad to sell the activity kit, advertise it on the Internet, and share revenues from the sales with BABEC.

Private Sector: Industry and Trade Associations

Some industry and trade associations, such as the American Electronics Association, FFA Foundation, and the American Hospital Association provide funding as well as in-kind support to schools, colleges, and education-business consortia to develop and operate education-to-employment programs in their industries.

Labor unions, such as the AFL-CIO, Communication Workers of America (CWA), International Brotherhood of Electrical Workers (IBEW), and Service Employees International Union (SEIU), provide extensive funding and in-kind services to develop and use skill standards, and help schools prepare current and future workers.

Private Sector: Professional Organizations

Some professional organizations, such as the American Women of Science, the American Association of Nurses, Professional Association of Innkeepers, and Society of Industrial Microbiologists, provide various kinds of assistance to schools, programs, and individual students preparing to enter certain industries or occupational clusters.

Strategies for Obtaining Support

System and program developers who have successfully raised funding or in-kind support for their endeavors suggest several strategies for accessing information about funding sources and obtaining support:

Websites: All federal and state agencies, foundations, and most companies have websites; look through all appropriate websites for information about grant programs, foundation interests, and various other potential sources of support for the work you are doing; contact these organizations to obtain information about what they support and how to apply for funding.

Advertise: Advertise your system or program and its goals in organizational newsletters, local newspapers, on the Internet, at conferences, and other places where potential funders may see them.

Circulate: Circulate "wish lists" for needed materials, equipment, supplies, and various kinds of in-kind assistance (classroom speakers, class instructors, internships, etc.) to local employers and other organizations.

Think creatively: Think creatively about how to use existing resources in new ways to support development and operation of the system and programs (e.g., providing sabbatical time for instructors to develop and direct a program, rather than for some more traditional purpose; reallocating some administrative funding to support teacher team meetings that help develop curriculum materials).

Involve local industry: Involve local industry representatives, government, and other organizations early on in your system inception; the more these partners can participate in shaping the coalition, the more likely they are to contribute to it.

Commitment to support: If possible, get commitment to support your system written into a company's business plans, and/or their development agreements with government; BBEI was able to have Chiron Corporation include funding for support of the BBEI system in their business expansion plan in the Berkeley, California area.

Complete company buy-in: Get complete company buy-in from top to bottom (from CEOs to frontline workers); the CEO and top management must approve the company's participation in the system; the technical supervisors and employees will be doing most of the actual work (e.g., supplying materials and equipment, supervising interns, reviewing curriculum, visiting classrooms).

Allow employees some work time to contribute: Encourage local business managers to allow their employees some work time to contribute to local education endeavors during work hours and to provide rewards (bonuses, certificates, appreciation events, etc.) to employees who work with education institutions.

Lobby: Lobby your state legislature to give tax credits to companies for "loaning" employees to work with educational institutions.

Involve local industry associations and professional groups: Involve local industry associations and professional groups in your system; these groups provide opportunities for networking and making personal contacts and connections.

School-Based Production: Arrange for your students to produce a basic product that a local employer needs. Products can also be made for and marketed to other schools for their use.

Build personal alliances: Build personal alliances; take time to build relationships that will attach a face to an endeavor, and help make a concept more concrete.

Planning and Operating Programs

Program development and operation is the engine of any education-to-employment effort. It creates the framework for concepts, policies, and relationships, developed by the system members, to be implemented in classrooms, and at work and community-based learning sites. It coordinates all of the participants, structures, and operations required to make teaching and learning possible.

Programs must be designed to meet the needs of various student populations—high and low achievers, at-risk young people, inexperienced adults, adults changing careers, and other groups. They also must meet the needs of various system partners—education institutions, employers, government, unions, community groups, and others. Programs also must meet legislated federal, state, and local mandates, often within the structural and operational constraints of local education, work, and community institutions and policies.

Unlike traditional vocational education, which often did not provide sufficient conceptual learning to prepare students for higher levels of education, today's technical education programs must be designed to meet the criteria set by both higher education institutions and the labor market, to give all students options for their future. This means programs must provide learning experiences that enable students to meet both academic standards in various disciplines and skill standards for success in the workplace. Higher-level technical education programs must also meet skill standards for particular industries or occupation clusters. All students must be prepared to progress to higher education levels or to enter the workforce.

From our experience observing and assisting education-to-employment programs, we have identified a number of features that can be found in education-to-employment programs working to meet the criteria we have outlined above. Theses features include the following:

- Strong philosophical and financial support from education administrations, industry unions, and government;
- Advisory boards consisting of educators, local employers, workers, government and community leaders, and other stakeholders;
- A paid third party to direct and coordinate the operations of the program;
- Curriculum that integrates academic and technical learning, in all disciplines;
- Curriculum that enables students to meet high academic standards in all disciplines, and industry skill standards;

- Pedagogy that mirrors high-performance work and work organization – such as team teaching and learning, project-based, problem-centered learning, contextual learning;
- Extensive opportunities for teacher/instructor and counselor professional development;
- Access to state-of-the-art equipment, materials, and procedures;
- Various opportunities for interaction with workers – in school, workplaces, and the community – to help students learn about career opportunities, requirements for various careers, and become familiar with different work settings;
- Work-based learning experiences, with trained supervisors, that are coordinated with school-based learning;
- Competency-based assessment methods, as well as knowledge assessment methods, all geared to high standards
- Articulation among various levels of academic institutions to increase the ease of and maximize opportunities for education advancement.

In this section we examine several key questions that program developers and managers often ask. We present a number of case studies and shorter examples of programs that explore these questions and contain all or most of the features we have identified.

Key Questions

1. How can programs be developed that prepare students for multiple future options – further education and/or immediate employment?
2. Why is it important to have the commitment and involvement of Education Administrators, Industry Employers, and Workers in a Program, and How Can they help?
3. How can a program operate smoothly, and why is a paid third party essential?
4. How can a variety of populations and needs be served, and how can students be recruited into the program?
5. How can work-based learning strengthen a program, and how can it be developed and managed?

How Can Programs Be Developed That Prepare Students for Multiple Future Options—Further Education and/or Immediate Employment?

To create programs that will prepare students for both further education and employment opportunities, program developers must access information about the needs and resources of the different stakeholder groups in their education-to-employment system. Examples of such information are labor market projections for industries and occupations, admission requirements for higher levels of education, and needs of different potential student groups. Examples of resources are administrative support from education officials and institutions, philosophical and financial support from local employers, government, unions, and community groups. Program developers and implementers then must obtain or develop the types of curricula, pedagogy, professional development, student assessment, scheduling and other components that will best enable them to reach their goals.

How Skill Standards Can Help

Skill standards can be used to set the employment and career development goals of a comprehensive education-to-employment program. Used with the assistance of employers and workers from local industry, the standards can identify the content and level of mastery the program must help students attain to qualify for industry entry. The standards then can be used to identify what skills and knowledge are best learned in the classroom and what can be practiced and learned in work-based learning sites.

Used in conjunction with academic standards in various disciplines, the skill standards can help shape the framework of learning for an education program. They can be used to identify structural changes (e.g. scheduling, work and community site learning) that need to be made, as well as what professional development teachers/instructors may need.

This section includes some case studies and examples of programs that are doing these things. Each case study or example illustrates at least several of the "best practice" program features we have mentioned. Together they represent a range of successful programs that provide students with skills and knowledge for multiple future options.

Berkeley Biotechnology Education, Inc. (BBEI)

The program operated by Berkeley Biotechnology Education, Inc. (BBEI) in Berkeley and Oakland, California, is an outstanding example of a comprehensive education program that contains virtually all of the elements we consider necessary for a successful education to employment endeavor. Begun in 1993, with start-up funding from Bayer Corporation, the program is a 2+1 program that includes a two-year high school component articulated with a one-year bioscience certificate program at the community college level, both which are integrated with paid work experience in lab settings. *(See case study in Developing Systems section for description of the development of BBEI).* In 1997, 115 students were enrolled in the BBEI program. The first group of graduates completed the Laney College program in June 1997. All students who received certificates are currently employed full time in the biotechnology industry (in five different companies, with an average salary of $30,000 a year).

The program consists of nine parts, which indicate the breadth of its coverage.

A comprehensive 2+1 program, with extensive industry support and participation, and well-developed school and work-based learning

1. *High School Program* - a two-year component for 11th and 12th grades that includes a special hands-on biotechnology curriculum, small class size, and a competency-based grading system *(See exhibit 3A);*
2. *Paid Summer Internships* - in a laboratory or laboratory support position for students in the program, closely coordinated with the school-based component, and supervised by trained workers;
3. *Community College Program* - a Biotechnology Career Institute, a one-year, 19-unit certificate program that offers an appropriate curriculum, and is articulated with the high schools and with industry, with emphasis on hands-on lab training and specially designed science courses;
4. *Co-op Employment for Community College students* - attracts companies to partner with BBEI and expands the pool of companies to provide students with year-round work experience related to their studies, and establish relationships for possible future work opportunities;
5. *Paid Teacher Internships in Industry* - provides teachers with direct, hands-on experience in industry and information to understand and become better prepared to teach students the kind of skills they will need to acquire jobs in the biosciences;
6. *Job Placement* - services, including employment development, counseling, and other assistance to the transition from school to the workplace;
7. *Industry Outreach* - continually expand the engagement of industry partners to ensure alignment of program with industry needs and collaboration;
8. *Support Services* - for participants and their families (including mentoring, tutoring, counseling, and helping families understand work-based learning) to help ensure successful program participation and completion;
9. *Evaluation* - on program and all components and data collection on participant outcomes.

BBEI's Curriculum Development and Educational Issues Committee (formed by educators and industry representatives) meets regularly to review courses and curriculum to ensure relevancy to industry standards and expectations. The curriculum and instructional strategies are designed to mirror the content and process of work in a bioscience work setting.

Students often work in teams, taking on individual responsibilities for the

Exhibit 3A: Course Description
Berkeley High School Biotech Academy

Fall and Spring Semester, Junior Year — Unit Val.

Biotechnology 1 and 2 (ea. sem.) 5

Prerequisite: C average in Math (IMP) 1A and 1B, Math (IMP) 2A and 2B or Algebra 1 and 2, and Geometry 1 and 2; and B in IAC Chemistry or Intermediate Biology; or C in Chemistry or Advanced Biology.
Satisfies U.C. "f" requirement only.
Priority will be given to students residing in west and south Berkeley.
Topics covered are: laboratory measurement and calculation, energetics of life, growth and reproduction, structural basis of function in living systems, chemistry of living systems, use of computers as a tool for writing, quantitative problem solving and data acquisition and display. Issues of career development, ethics and technology and historical aspects of technological development will also be stressed.

Summer after Junior Year — Unit Val.

Field Studies - Summer Internship in Biotechnology 0-5

Prerequisite: recommendation of Biotech Academy instructor and hire by local biotech company.
Students will work as interns in a laboratory or production area of a biotechnology company for 160 hours. The internship will help students acquire and practice laboratory skills, further understanding of the integrated nature of science and provide an environment conducive for in depth performance of science. Credit is based on number of assignments completed.

Fall and Spring Semester, Senior Year — Unit Val.

Biotechnology 3 and 4 (ea. sem.) 5

Prerequisite: Biotechnology 1 and 2 with a grade of B or better
Satisfies U.C. "f" requirement only.
Topics covered are: chemistry and biochemistry concepts related to biotechnology, genetics, DNA transformations, protein purification techniques, cell growth and monitoring techniques, immunology and other aspects of biotechnology.

CASE STUDY CONT'D

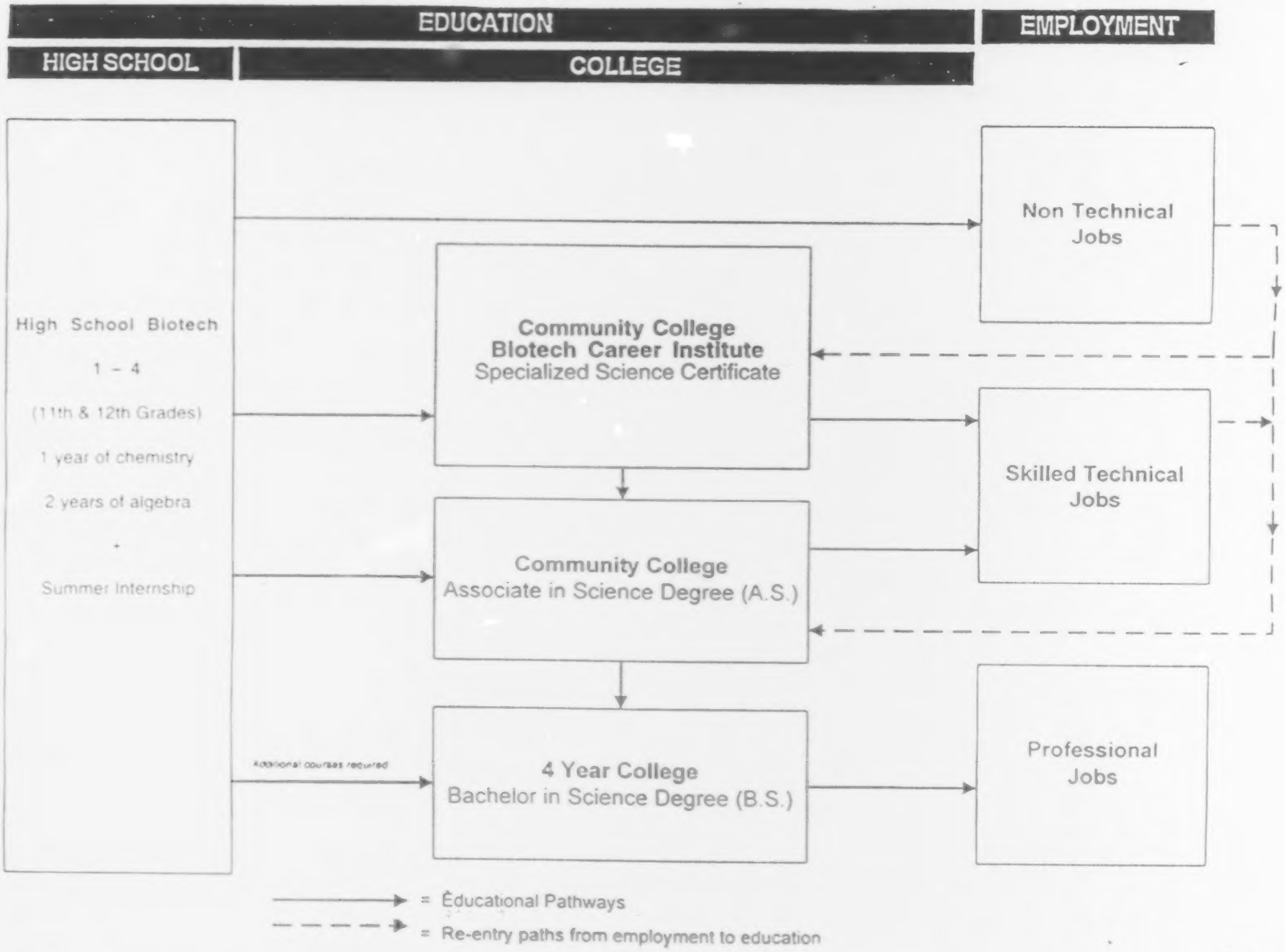
group's work. They work together on complex projects that require the use of multiple skills and knowledge. Sometimes the teams compete, with the winning team receiving token "rewards." Students spend as much time as needed on experiments and procedures to get them right, as they must do in industry. Teachers remind students of industry standards: If students are late, or inattentive, or keep their work areas messy, they are reminded that "this is their job," that "this behavior would not be tolerated at work," and that "their coworkers would be upset with them by this." Students follow real industry protocols and keep accurate laboratory notebooks (according to industry standards). If they know they will be missing a class, they must notify the teacher or school office that they will not be there. If they wish to drop out of the program, they must write a "letter of resignation."

The program developers use the national bioscience industry skill standards to assess the content and relevance of the curriculum in various program components. The skill standards are also used to align the various school and work-based components of the program by deciding which task, skill, and knowledge areas are included in each of the program's components (e.g., high school, community college, internships). The skill standards are used to help orient work-based supervisors about the essential elements of the students' work experiences. They are used by both teachers and work supervisors to chart the progress of students. The bioscience skill standard scenarios are given to students for role playing, to act out a situation where something has gone wrong, and to discuss possible solutions to that problem and other possible situations. The scenarios also are used by students to practice for job interviews.

The program staff are committed to providing multiple education and career path options for its students, as well as the support services and structure needed to succeed. Students and their parents are given a flow chart showing multiple education and career path options, and are required to develop an individualized education plan. as well as a contingency plan. (*See exhibit 3B.*) Courses are broken down into modules so that students may repeat any given module if they do not master it the first time. Students must receive an A or B grade to pass a module. If a student is having difficulty in a course, he/she is required to meet with a tutor during lunch, before or after school to master the material. (*See exhibit 3C.*) Students receive certificates upon successful completion of each module; this practice serves as an incentive to continue to do well in all high school classes as well as continue postsecondary education.

Every enrolled high school student participates in at least one paid summer internship between the 11th and 12th grades in local bioscience workplaces, where they receive hands-on experience in various research and production processes. They also learn professional behavior suitable to the workplace with coworkers. All community college participants work in year-round co-op jobs in the industry to learn and perfect skills. All students are supervised by trained work-based supervisors. (*See case study later in this section about work-based learning.*)

Exhibit 3B: Education/Career Path Options for Students in BBEI's Programs



Berkeley Biotechnology Education, Inc., 1998

BEST COPY AVAILABLE

Exhibit 3C: BBEI Grading Policies Letter of Agreement

THIS COURSE IS A COMPETENCY-BASED CLASS, ATTENDANCE ALONE WILL NOT GUARANTEE A PASSING GRADE IN THIS CLASS. YOU MUST EARN AT LEAST 80 PERCENT OF THE POINTS OFFERED TO PASS.

Dear Student and Parent/Guardian:

Your grade will be determined from written examinations, lab practicals, and daily assignments. Examinations and lab performance must be completed with a grade no lower than a "B". Anything less than a "B" will be considered to be a "failing".

This system is very different from your other classes. A "C" or "D" in English or Math still gives you credit toward graduation, regardless of what you actually learned. In this class you must demonstrate mastery. You may not "slide by".

Any lab or test work performed at less than 80 percent will have to be redone. This may sometimes require that you give up your own time during your lunch break or after school. You will be given enough chances to master a particular skill or concept, but you must be willing to take the initiative to ensure this.

This course is set up for your success. But you must make the commitment to learn what is presented.

In addition, this class involves a lot of lab activities. Being tardy or absent creates a great deal of extra work for the instructors and will not be tolerated. If absenteeism or tardiness becomes a problem, you will be asked to leave the program.

We want you to succeed. You must decide whether or not you want to work to achieve the program's goals in the course once you know these expectations. You and your parent or guardian must sign the statement below and return it. In this way we all can be assured that everyone knows and understands the expectations and requirements of this special science program.

I have read the Grading Policy Statement of the Biotech Academy. I am aware that the lowest passing grade in this course is a "B". I understand that if my son/daughter or ward does not achieve this grade that he/she will not pass the class. I understand, too, that multiple opportunities will be given to students to allow them to demonstrate mastery of each concept or skill being presented.

Student Signature

Parent/Guardian Signature

CASE STUDY CONT.'D

BBEI provides extensive support services, including tutoring, a scholarship program, a bonus incentive program which provides students with stipends, providing transportation to guarantee student participation in various program activities, providing referral to emergency services as needed, and arranging for leadership opportunities for students to speak publicly about their participation in the program with fellow students, parents, industry representatives, and community leaders.

Teachers also receive extensive support. When a teacher is working with new material, another teacher is available, to observe, assist the students, and give the teacher assistance and feedback. During implementation of the initial curriculum, program design includes two teachers in a classroom—one to teach, and the other to observe and "learn the ropes" so that he/she can teach it next. When the program began in 1996, at Fremont High School in Oakland, Berkeley teachers met every three weeks with the Oakland teachers to help train and support them in understanding the program's philosophy, curriculum content, teaching methods, assessment and grading procedures, use of equipment and materials, and planning for subsequent units of study. In addition, graduates of the high school program, who have transitioned into the community college, work as paid assistants in high school classes at Berkeley and Fremont High Schools.

The BBEI Third Parties

The extensive and in-depth components provided by BBEI are important to the program's success. They require that BBEI solicit program support from industry and private foundations (*See case study on BBEI in Developing and Maintaining Systems section*), including support of a full-time program staff. The BBEI staff is quick to acknowledge that without a full-time paid staff (a third party) to manage the many and complex roles and activities of connecting school and work-based learning, a comprehensive, effective, education-to-employment program would be difficult to achieve. Some of the work of BBEI's staff includes; connecting the program to industry, managing various committees and their work; fund-raising; and providing innumerable types of assistance needed by students and families, teachers and instructors, work-based supervisors, school administrators, and the many other system participants.

The BBEI staff consists of an executive director, a deputy director, an education director, a workforce coordinator, and an administrative assistant. The executive director administers the program and interacts with members of the board, advisory committee, industry executives, students, and others in the school system and community. The education director works more directly with the teachers, instructors, students, and work-based supervisors, and handles many of the details required to ensure that the program runs smoothly in the classrooms and the workplaces. The workforce coordinator is responsible for maintaining and increasing the number of positions for interns and co-op workers. Without the support, commitment, knowledge, and hard work of the third party, this comprehensive program probably could not be the success that it is.

EXAMPLE

Middlesex Community College (MCC) - *an innovative, interdisciplinary career-oriented program at the community college level articulated with a high school and a four-year college*

Middlesex Community College, in Bedford, Massachusetts, has developed an interdisciplinary program that grants both one-year certificates and two-year associate degrees in the field of biotechnology. With support from the National Science Foundation, MCC formed a working team of instructors in biology, biotechnology, chemistry, mathematics, English, and economics and management. Their task has been to integrate into their regular courses activities that contain the information and skills students in the biotechnology program must master.

Although interdisciplinary programs are becoming more common at the high school level—in academies as well as other types of programs—they are almost nonexistent at the college level. To arrange for college instructors in different departments, on differing schedules, to think and work together in differing ways and focus on a discipline that may be foreign to them has been a challenge for this program. Each disciplinary department tends to reinforce its own approach to conceptualizing and teaching. In addition, some union contracts inhibit instructors from attending meetings that are outside of their own departments.

The program organizer approached various division heads in the school to identify faculty who might be amenable to working as a team and to incorporate aspects of the field of biotechnology into their courses in various other disciplines. It was challenging for instructors from various academic disciplines to bridge the "culture gap" between academic and technical education, and academic instructors to care enough about the subject of biotechnology to work on incorporating it into their courses. However, with the assistance of curriculum developers, and instructors in the biotechnology program, all of the instructors eventually were able to develop course modules with activities and related readings that incorporated examples from the field of bioscience.

Courses in the two-year biotechnology program include biology, chemistry, biochemistry, molecular biology, math for technology, English composition, and methods of biotechnology. Topics such as use of computers (word processing, recording data, using charts), bioethics, quality control, economics and management (equipment and supplies, scientific management), statistics, graphing, following Standard Operating Procedures and Good Manufacturing Practices, and other topics that entry-level biotechnicians are required to master are included.

The instructors work together to ensure that all of the knowledge and skills required of an entry-level biotechnician are covered and reinforced in the various courses. These requirements were based on the information in the national bioscience industry skill standards. Each instructor has identified the tasks, skills, knowledge, and behavioral attributes contained in the bioscience skill standards that can be taught in their courses. Every module developed for each course lists those skill standard components that are taught in the course, classroom, or laboratory activities, and assessment methods that measure how well students have mastered each of the components. (*See exhibit 3D.*) In addition, instructors have developed work-based scenarios, similar to those in the bioscience skill standards, which present a real-life situation that students must resolve. In doing so, they demonstrate mastery of a number of tasks, skills, knowledge areas, and behaviors contained in the standards.

Exhibit 3D: Sample from Microbiology Module

Chart B specifies the task , and the activities the student will do within the modules to master this task. The module number is noted in parentheses for activities found only in specific modules. For each task, an assessment technique is suggested.

Chart B

Task	Activity	Assessment
Obtain and read SOP	Preparing for Labs- reading procedure	Student begins and continues with lab procedure with minimum guidance. Instructor spot checks progress of lab pairs
Prepare sample for testing	Serial dilutions (II, V, VI) Inoculate broth (II, III, IV, V, VI) Streak for isolation (III, IV) Aseptic transfer	Successful outcome/completion of experiment. Student able to count cells. Instructor views plate for presence of pure colonies. No contamination of cultures visible.
Assess acceptability of specimen	Inoculation, Assessment and Subculturing of cultures(II, III) Maintenance of Cultures over long periods of time (III)	Student maintains a log documenting culture history. Log is submitted to Instructor. Cultures are submitted to Instructor for critique. Student submits a sample tracking sheet of inoculations.
Perform tests/assays: Chemical, biological, environmental	Bioburden sampling (I and VII) Use of Selective and differential media for identification (IV) Selective media for isolating mutants (V)	Student writes and discusses results of tests. Student able to identify an unknown microorganism and make a presentation on their data and methodology of testing. Student able to locate mutants by comparing growth patterns on different media..
Perform histotechniques where needed	Gram Staining (III and IV)	Student prepares slides. Instructor verifies student performance by viewing slides and asking questions.
Return, archive or dispose of samples	Contaminated media and plates are labeled and placed in proper receptacles.	Instructor monitors that waste is disposed of according to instructions. Student maintains a waste disposal log.
Follow SOP	Performing Lab Procedures	Student follows lab procedure. Instructor spot checks progress during lab.
Prepare buffers and solutions	Prepare and dispense solid and liquid media (II)	Media used for cultures, media remains sterile and supports growth of bacteria. Instructor monitors cultures.
Obtain, process and store product samples	Media and cultures are placed in refrigerator after incubation	Student completes tracking log. Student can find samples easily when needed.
Obtain and Label sample/specimen	All plates, test tubes and bottles are properly labeled by students during lab procedures.	Instructor spot checks adherence to protocol.
Clean work area according to SOP	Working areas disinfected before and after every lab activity. Unused supplies and equipment returned to proper location.	Student maintain cleaning and disinfection log. Instructor monitors that work area is cleared.
Sample environment	Students sample laboratory area for presence and persistence of microbial growth. (I and VII)	Student performs the procedures, analyzes and discusses the possible cause of any observed microbial growth
Ensure clean room integrity	Disinfection of work area, wearing gloves, coats and eye protection.	Instructor monitors during lab activity.
Follow universal precautions for biological pathogens	Students practice aseptic technique during all lab activities.	Contamination of cultures is monitored by student and instructor.

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The MCC biotechnology program is articulated with the Biotechnology Academy program at Minuteman Science-Technology High School and Adult Career Center, in Lexington, Massachusetts. Students in the high school program can earn credits toward an MCC degree for certain courses taken in high school. The MCC program is also articulated with Worcester Polytechnic Institute, a four-year college. MCC program graduates can go directly to work in the many biotechnology, medical research, and medical instrumentation workplaces in the area, or they can continue with their education. Students in the MCC program include young people graduating from high school, as well as adults training or retraining for new careers.

Biotechnology Academy, at Minuteman Science-Technology High School and Adult Career Center - *an interdisciplinary, standards-based program that uses high-performance teaching strategies*

The Biotechnology Academy at Minuteman Science-Technology High School and Adult Career Center, in Lexington, Massachusetts, is an excellent program model for the integration of academic and technical training. The academy model is based on the immersion of students into an intense, hands-on approach to scientific inquiry.

The program first requires the commitment of the faculty to a fully integrated approach to teaching. For example, a unit on the isolation of the protein casein from milk requires students to synthesize elements from his or her courses in chemistry, biology, mathematics, and communications. The instructors are in close communication with one another and collaborate on the design of the courses, allowing them to achieve full integration.

The academy is designed around real-life scenarios which require students to use their skills and knowledge to solve real-life work problems. The students work in teams that perform tests, pool the data, achieve consensus, and produce written reports. The program uses the same type of scenarios as those in the bioscience skill standards.

The curriculum at the Biotechnology Academy is written to provide as complete an integration as possible of technical and academic material. The hands-on activities, labs, and scenarios are designed to address aspects of biochemistry, biology, process measurement and control, molecular biology, bioethics, how historical events shape science, the business of biotechnology, and popular perceptions of science. The common thread uniting them all is the application of scientific methodology to solve problems and answer questions. The Minuteman program is an outstanding example of the integration of technical and academic education, combined with a faculty committed to working together.

Biotechnology Academy at Southern High School, Baltimore, Maryland - *an inner-city comprehensive, career academy articulated with two- and four-year colleges and with work-based learning*

The Biotechnology Academy program at Southern High School in Baltimore is one of four career academies within that school. The academy serves students from the entire Baltimore City school system. The program and curriculum content are based on the results of a DACUM (developing a curriculum) job analysis conducted in 1992 to determine what students needed to learn to become laboratory technicians in the Maryland bioscience industry. The program is a rigorous four-year curriculum in which the same teachers stay with the students all four years. The teachers and students meet monthly to discuss issues related to the program.

The ninth-grade year includes a "success" component in which students are taught basic skills, such as reading, time management, interpersonal skills, stress reduction, and other skills intended to help them succeed in school and transition to higher education or to workplaces. The 10th grade includes a course that prepares students for test-taking (SAT prep course) and college selection, as well as career exploration. The last two years focus on job skill development through work study internships and/or community college preparation. All courses require rigorous academic learning. (*See exhibit 3E.*)

The academy students engage in hands-on, project-based learning, in teams, to conduct experiments and practice laboratory techniques. They use real work-based scenarios to learn interpersonal and technical skills, and make use of newspaper articles and other real-life sources of information. Students also learn how to develop lesson plans by assisting with teaching third-and fourth-grade students.

Since the program began, students have taken field trips to large and small area companies, a police forensics lab, the state agriculture center, and the U.S. Army Bioprocessing Unit. They have worked on a NASA research project and have had internships at the Columbus Center for Marine Biotechnology, local pharmaceutical and biotechnology companies, and other local work sites. All 12th-grade students participate in an internship. They take classes in the morning and work in the afternoons and/or on weekends. They receive course credit for work during school hours and are paid minimum wage for work done outside of school hours.

All of these activities have given the students a great deal of exposure to the technical skills necessary to succeed in the biotechnology industry. Recently, with additional funding from the state of Maryland, Southern High students are now eligible to take additional courses in the SciTEC program offered by the Columbus Center. The students are also eligible for full-time jobs during the summer through a program in the mayor's office.

Southern High is one of two Baltimore City high schools that are articulated with Baltimore City Community College (BCCC), as part of a 4+2+2 program developed with a Tech Prep grant from the U.S. Department of Education. Two academy courses, Biotechnology I and Biotechnology II, provide college-level credits accepted by BCCC. There are a total of 150 students in the Southern High Biotechnology Academy. Almost all of the graduates either go directly to higher education or into employment in bioscience or related health fields.

EXAMPLE

Baltimore City Community College (BCCC) - *A multifaceted community college program and crucial part of a citywide articulated career pathway in biotechnology*

Baltimore City Community College is the only state-run community college in Maryland (the others are locally controlled). BCCC's program is designed to

- provide planned, sequential courses of study that focus on career planning and lifelong learning;
- avoid unnecessary duplication of instructional courses and programs;
- provide advanced educational opportunities at the community college level;
- offer students opportunities to complete a program that is linked directly to college credit and that prepares them for employment, further education, or both.

Exhibit 3E: Biotechnology Sequence of Courses

9th Grade	• Biotech I • Chemistry • English I • Algebra I • Keyboarding • Language (optional) • Success Course (study skills, time management, classroom issues, stress, writing, project-based learning, interactions, electives, history • others all electives
10th Grade	• Biology 1 (molecular-based, full year) • English 2 • Computers and Science • US or Government History (including • • a history of biotechnology) • SAT Prep 1 • Elective (art, music) • Algebra 2
11th Grade	• Microbiology - 1st semester • Genetics - 2nd semester • Geometry • Technical English (research, industry, research/science) • SAT Prep 2 • Success Seminar - prep for college, college applications, visits to colleges • Language (second half) • Work Study internships - 5 days a week unpaid - lab based at COMB, BCCC, etc.
12th Grade	• Pre-calculus (statistics-based • Technical writing III • Biotech II • Work Study

BCCC and the Baltimore City Public Schools promote the sharing of faculty, facilities, and other resources in an effort to reduce costs and avoid duplicate training and services. BCCC recently opened a new $18 million Life Sciences building, with extensive science laboratories, classrooms, and other facilities to serve the school and other institutions in the community.

BCCC has the only community college biotechnology program in the Baltimore area. This program is the second piece of the 4+2+2 articulated biotechnology education system. High school students must receive a grade of C or better in an approved course to meet articulation requirements. Tech Prep scholarships are available for applicants who major in biotechnology, business technology, child care, or electronics technology; have a B or better grade point-average; have graduated from a Baltimore City public school; and are accepted as full-time students at BCCC.

The college conducts open houses for high school biology teachers, chemistry teachers, and counselors to discuss their programs and encourage them to bring their students for an orientation to the college. It also offers the students an orientation to the college campus and an introduction to available services. A course is also offered to new students on how to take notes and exams, and how to succeed in school.

The BCCC biotechnology program has an advisory board that includes representatives from other education institutions, industry, government, and community-based organizations in the Baltimore area. Among the organizations represented on the board are the Baltimore City Public Schools, the Center for Marine Biotechnology, Microbiological Resources, Osiris Therapeutics, Bio Science Contract Productions Corp., Oceanix, Scios-Nova Inc., Becton Dickinson, The University of Maryland School of Medicine, Johns Hopkins University, and Southern and Dunbar High Schools. This advisory board helps maintain the focus of the program on the needs of student and the needs of the biotechnology industry in the Baltimore area.

All students in the biotechnology program at BCCC are required to have at least 250 hours of internship experience at area workplaces in order to graduate. BCCC is articulated with the University of Maryland School of Medicine, Department of Medical and Research Technology, which offers bachelor of science degrees in medical technology and biomedical science research.

William Donald Schaefer Life Sciences Institute - *a BCCC institution serving the life science education, corporate, and economic development needs of the Greater Baltimore area*

The William Donald Schaefer Life Sciences Institute (WDS LSI) was created to provide life science education, training, and information services to the citizens of Baltimore and to life sciences corporations in the area. It was initially founded several years ago through the joint efforts of the Greater Baltimore Committee and BCCC to identify the importance of the life sciences in the economic development of metropolitan Baltimore. Community outreach programs of the institute have included the following:

- *Robert W. Coleman Elementary Scientists Program* - a science education program for elementary grade students;
- *Science is for Everyone Program* - a Saturday academy for local children, run by community churches and BCCC;
- *Academic Champions of Excellence* - a middle and high school program, in association with Morgan State University;

- *Project Prime* - a collaborative effort to increase the number of African-American youth that graduate from high school and earn a college degree (with emphasis on math and science teaching careers);
- *Summer Science Institute* - for Baltimore City elementary and secondary school teachers;
- *Biology: Linking Standards and Technology* - for Baltimore City secondary school teachers;
- *Chemistry/Physics: Linking Standards and Technology;*
- *Mathematics: The Active Classroom* - designed for middle school classes;
- *Maryland Collaborative for Teacher Preparation* - a joint effort to train future science and math teachers;
- *Health Careers Opportunity Program* - which enhances the preparation of African-Americans for careers in the health fields;
- *Third Annual Mid-Atlantic Microbiology Educators Conference;*
- *Women 2000* - a women's health conference supported by BCCC, Partnerships in Health, and the Center for Disease Control and Prevention;
- *Corporate Training Programs* (through the Business and Continuing Education Center), such as training for pharmacy technicians, in cooperation with Neighborcare and the University of Maryland Medical Systems. A contract with Johns Hopkins Hospital STELLAR program to train clinical associates for hospital and health-care systems, DP training for local health-care organizations, a laboratory technician training program for Chesapeake Biological Laboratories, and a bioscience technician training program, funded by the Greater Baltimore Advanced Technology Council, consisting of seven modules, and used by area bioscience employers to train their employees.

EXAMPLE

University of Maryland School of Medicine (UMSOM), Department of Medical and Research Technology (DMRT) - *a two-year, bachelor of arts/bachelor of science degree program articulated with community colleges*

The University of Maryland School of Medicine, Department of Medical and Research Technology, in Baltimore, is the last link of the 4+2+2 biotechnology articulated education system. Students who graduate from BCCC with a tech prep certificate, as well as students from all other accredited community colleges in Maryland with appropriate qualifications, are eligible for the junior-senior year baccalaureate program in the Department of Medical and Research Technology (DMRT) at UMSOM. The University of Maryland Chancellor's Office encourages students to continue through the last two years of college by offering $1,000 scholarships to those who are eligible.

The program at UMSOM-DMRT offers two-year programs in both medical technology and biomedical science research. The medical technology program focuses on clinical laboratory work and health care. The biomedical research program focuses on laboratory techniques and other subjects related to work in the biotechnology field. The medical technology program has four clinical rotations, each lasting six weeks. The biomedical research program has two work-based learning placements—one in a biotechnology work site, and the other in an academic research site. Placement sites include MedImmune, Osiris, Human Genome, Covance, and the UMSOM System. In all, 200 placements were made in 1999 in 30 institutions. Students are often hired by institutions in which they have had placements.

UMSOM participates in open-house events for high school and community college students to interest them in the DMRT program. Juniors and seniors in the DMRT program are required to give brief, hands-on presentations about techniques used in biotechnology laboratories. This showcasing method has been effective in attracting students to the program.

The school has designed a flexible curriculum, allowing students to take an additional year to complete their studies. Because many of the program's students are adult learners, this extra year allows them time to balance their work, family, and school responsibilities.

Abraham Lincoln High School - *a rigorous course that integrates academic and technical learning for all students, and provides career awareness and opportunities for further education through its many links to higher education and industry*

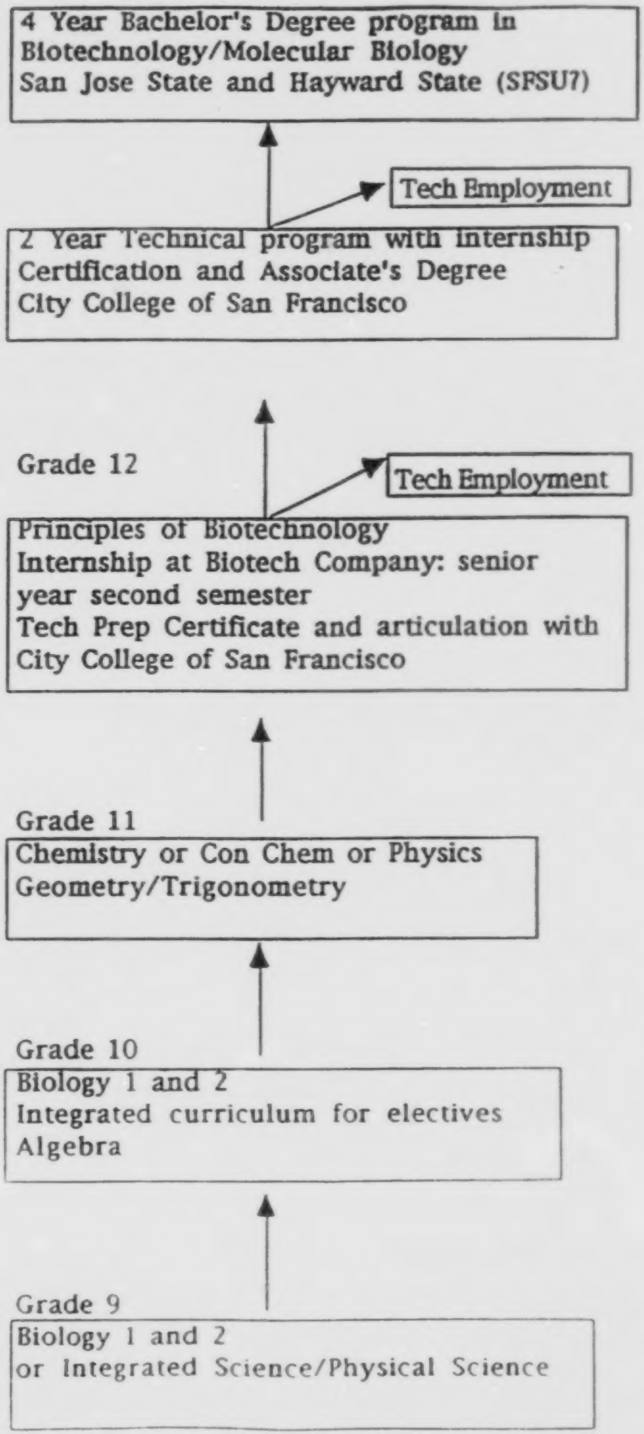
Abraham Lincoln High School, located in San Francisco, California, offers a Principles of Biotechnology course for students in grade 12. Groups such as San Francisco Bay Area Science Education (SFBASE), the University of California at San Francisco Education Partnership, Stanford University's Human Genome Education Project, Genentech, Inc., and other local education and industry organizations all contribute assistance, as well as equipment and materials, for the laboratory exercises. The course is designed to introduce students to the potentials that biotechnology offers and to provide rigorous academic education as well as some biotechnology training.

The goals of the course are to

- match the course to state frameworks and adapted district curriculum;
- provide a seamless school to college career ladder for students through an articulation agreement with City College of San Francisco, Hayward State University, and San Jose State University;
- arouse student interest in and awareness of current trends, issues, and opportunities in genetics and biotechnology;
- prepare students for future study in molecular biology with a rigorous academic course that will provide a head start for many undergraduate biology and chemistry courses;
- increase student awareness of the range of potential career opportunities in the San Francisco Bay Area;
- prepare students for employment at the introductory level of laboratory assistant in a biotechnology company;
- increase student awareness of social and ethical issues engendered by the biotechnology revolution.

The course includes a thorough overview of ways in which the revolution in molecular biology has had an impact on history, science, techniques, and technologies. The first part of the course explores the inheritance and physiology of genetic diseases to arouse student interest and review Mendelian inheritance. The second part focuses on key experiments in the history of DNA science as a model for studying the application of the scientific method. The third part examines DNA chemistry and the structure and regulation of genes. The fourth section deals with the human genome and social, legal, and ethical issues engendered by the new technologies. The fifth section is an in-depth analysis of the immune system, AIDS, and the impact of future biotechnology. (*See exhibit 3F.*)

Exhibit 3F: Biotechnology Career Pathway Model


4 Year Bachelor's Degree program in Biotechnology/Molecular Biology San Jose State and Hayward State (SFSU?)
Tech Employment
2 Year Technical program with internship Certification and Associate's Degree City College of San Francisco
Grade 12
Tech Employment
Principles of Biotechnology Internship at Biotech Company: senior year second semester Tech Prep Certificate and articulation with City College of San Francisco
Grade 11
Chemistry or Con Chem or Physics Geometry/Trigonometry
Grade 10
Biology 1 and 2 Integrated curriculum for electives Algebra
Grade 9
Biology 1 and 2 or Integrated Science/Physical Science

Many of the curriculum materials used in the course were culled from upper-division undergraduate texts and journal articles. Prerequisites for the course include two years of high school math, including algebra, as well as the instructor's permission. However, the course is designed to accommodate students with varying levels of ability.

Student performance is based on a total score of achievement in five sections of a "personal portfolio," including lectures; laboratories; at least one team project for each grading period (including written and oral reports); exams; weekly analyses of newspaper articles about current biology or biotechnology issues; and a journal, in which students express their thoughts regarding topics covered in class or their own ideas. Students can also earn bonus points for team effort. This is done to encourage students to work together.

Internships are made available for students who demonstrate particular interest and abilities in biotechnology. Students are also prepared to continue with their studies at local colleges or to enter the workforce directly in technical level jobs.

2 Why Is It Important to Have the Commitment and Involvement of Education Administrators, Industry Employers, and Workers in a Program, and How Can They Help?

Even the most dedicated and creative program directors and coordinators will find it difficult to develop and operate a successful education-to-employment program without the support and continuing involvement of education administrators and industry employers and workers. This is especially important because some of the most difficult barriers for these education programs can be the very education systems and industries the programs are trying to serve.

How Skill Standards Can Help

Skill standards can be used to help education administrators, employers, and workers understand the content of what students need to learn in classrooms and in workplace settings to prepare them for their future. Most sets of skill standards require that students learn a broad range of academic concepts and technical skills, as well as work attitudes and behaviors. This learning takes time and requires a carefully developed program.

Many employers are surprised when they see the extent and complexity of skill standards in their industry (standards which they and their employees have identified as required, even for entry-level positions). The standards help employers and supervisors understand the scope of what students must learn to enter their industry. The standards help them realize the amount and types of education that are required to help students reach that level. Employers and supervisors can then see that students and teachers need to have access to experienced workers; state-of-the-art facilities, equipment, and materials; work-based learning; and continuing dialogue with industry representatives about program and curriculum design, program operation, coordination of school and work-based learning, and other related issues.

Support from Education Administrators

Education administrators at the system and school levels must support the goals and structure of a program to be successful. If this support is not present, the education system can act as an internal barrier to development of successful education-to-employment programs. Following are some ways that education administrators can support the development of such programs, and the faculty that implement them:

- Become familiar with the goals, benefits, and requirements of education-to-employment programs, conferring with educators, employers, workers, and others who practice and support it;
- Provide funding for professional development and opportunities, including attending workshops, traveling to conferences, visiting work sites, and participating in workplace internships;
- Provide release time or additional pay for teachers who convene to develop and manage programs, create curriculum, work collaboratively with industry representatives, provide training to their peers, develop internships for their students, and other related activities;
- Reconfigure class and course schedules into block schedules to allow teachers to team-teach interdisciplinary curriculum and teach project-centered curriculum, laboratories, and other curriculum, that requires longer periods of time than traditional class periods and courses allow;
- Provide adequate facilities and equipment, in schools, or through arrangement with local companies or community-based centers, for teachers and industry representatives to conduct hands-on learning that mirrors work in real workplaces;
- Replace teacher assignments based solely on seniority or tenure with assignments based on individuals' possession of special knowledge, skills, and commitment.

Such support from administrators will encourage teachers, counselors, and others in the education system to become more involved in education-to-employment initiatives.

Once education administrators understand the content of what students must learn, which sometimes requires long-term, complex curriculum pieces, they can more easily understand the need for school schedules that allow teachers from different disciplines to work together, and for teachers and students to have extended periods of time to complete certain projects. They will also understand more clearly the need for specialized teacher professional development.

Employer and Worker Involvement

Extensive industry involvement is critical to a program's success. It is important to have local industry employers, unions, and individual employees involved in the inception of a program to ensure that the program is designed to meet industry needs. This early involvement will also help develop the commitment of employers, unions, and individual employees to participate in education programs in various ways and to hire graduates. The nature and extent of the employer and worker involvement may vary depending on individual employers' resources and levels of commitment.

The following are some ways employers and workers can participate in school-to-career programs:

- Provide tours of workplaces and facilities;
- Donate materials, equipment, and equipment maintenance to schools;
- Provide guest lectures and demonstrations by employees to schools;
- Participate in local program advisory boards;
- Provide shadowing and mentoring experiences for students;
- Provide supervised internships or co-op experiences for high school and college students;
- Provide supervised internships for teachers and other educators;
- Help develop high school and postsecondary curricula;
- Provide scholarships or other funding to support programs and students;
- Provide online assistance to teachers and school administrators about the industry and related curriculum topics;
- Participate in information sessions and forums to inform parents, students, and others about career opportunities in the industry, and how to prepare for them;
- Enable employees to teach classes or course modules at local schools.

Ideally, employers and workers should be involved with schools on an ongoing basis, not just stating their needs for trained workers and then waiting for schools to produce them. Having employer representatives on education advisory boards is one fairly simple way to maintain employers' presence during the development and implementation of programs. In addition to advisory board participation of employers, have workers and managers actually participate in the education process by providing mentorships, internships, and other work-based learning for students, teachers, and counselors. Have them develop curriculum, teach classes and courses in schools, provide professional development assistance to teachers, and help assess student achievement as well. (*See exhibit* 3G.)

Employers and workers can gain much from this participation, including

- a greater understanding of younger and entry-level trainees;
- development of management and training skills while supervising student workers;
- improved understanding of the educational process that prepares people to work in their industry;
- increased knowledge about their own work organization;
- "extra hands" to assist with current projects and backlogged work;
- in some cases, a subsidized intern (if intern is paid by education program);
- obtaining possible tax credits for hiring interns (if local or state government allows);
- prescreening potential job applicants;
- additional income, if paid to teach a course;

Exhibit 3G: Employer Recruitment Planning Form

Biotechnology Program Southern High School

Name: ______________________________
Title: ______________________________
Organization: ______________________________
Address: ______________________________
City, State, Zip: ______________________________
Business Telephone: ______________________________
Fax: ______________________________
Home Telephone: ______________________________

Availability and Time Preferences: ____________________
Days of the Week / Times: ____________________

Interest in Serving the Bioscience Program (check all that apply)

Interest in Hosting Career Exposure Activities

☐ **Work site visits**
☐ **Jab shadowing experiences**
☐ **Training sessions at workplace**
☐ **Job fairs**
☐ **Summer and/or part-time employment opportunities**
☐ **Apprenticeships**
☐ **Mentoring programs**
☐ **Leadership development programs**
☐ **Establish a Bioscience Library**
☐ **Share research project initiatives**
Other:

Interest in Providing Financial or In-Kind Assistance [check all that apply]
☐ **Financial Support $______________Amount**

☐ **In-Kind Assistance** ☐ **Equipment** ☐ **Supplies** ☐ **other**
Please specify:
Special Interests, Skills, Qualifications, or Training:

What would you like to get out of your volunteer experience?

Thank you for your involvement and investment!

- the satisfaction of contributing to the community;
- the opportunity to motivate young people to stay in school, and pursue careers in their field.

The following are some outstanding examples of how employers and individual employees are working with local school systems and two-year colleges to develop and maintain education-to-employment programs.

San Diego City College/Center for Applied Competitive Technologies (CACT)

The biotechnology instrumentation course, developed by an instructor at San Diego City College (SDCC), is a one-semester course that trains students with an academic background in chemistry and biology in major techniques used in the biotechnology industry. The college instructor serves as the course coordinator. Modeled after the Contra Costa College program, the course is divided into a series of modular protocols that are individually designed and taught by representatives from area biotechnology companies and research institutes. However, the SDCC has expanded the responsibilities of the industry instructors, faculty coordinator, and students.

A successful capstone course that utilizes industry-based instructors to help design curriculum, teach and assess students, and provide links to industry

Most of the instructors are supervisors of technicians or technicians themselves without advanced degrees. The faculty coordinator hires those instructors who have a zest for teaching, a willingness to take and respond to constructive recommendations, a commitment to sharing ideas, a belief that community college students can be good candidates for entry-level work in biotechnology, and a contextualized perspective of a technician's work. Instructors receive pedagogical instruction from the faculty coordinator. (*See exhibit 3H.*)

In 1997, 20 industry-based instructors were involved in the course. The companies they represented included Stratagene Cloning Systems, Inc., Advance Tissue Sciences, Signal Pharmaceuticals, Chiron Technologies Center for Gene Therapy, Vical, Biacor, Scripps Research Institute, Salk Institute for Biological Studies, and others. The instructors are paid an honoraria for their work. Funding for both the instructor honoraria and release time from other instructional duties for the faculty coordinator come from a Carl D. Perkins grant.

During each summer the course faculty coordinator meets with the industry instructors to review instructional objectives and design, content, teaching styles, and assessment. Consequently, the curriculum for the course is a joint product—combining the content and job experience of the industry instructors with the pedagogical knowledge of the faculty coordinator. The instructors and coordinator have developed certain standardized class

Exhibit 3H: Instructor Profile

Instructors of BIO 206 should:

1) philosophically endorse the concept that students with a minimum of one year of academic work in inorganic chemistry and one year of biology (including a lab-oriented microbiology course) can be made employable for entry level positions in biotech if given well-reflected guidance by industry teachers in a community college setting;

2) have a first-hand (contextualized) perspective of a technician's work;

3) enjoy the prospect of teaching a diverse group (12-20 individuals of various ages, cultures, academic and vocational backgrounds);

4) design and teach a protocol that will take a) 1-3 four hour sessions b) be complete in that in the presence of the instructor, data will be collected & analyzed, and time is allotted for a "debriefing/summary," and c) nurture skills, attitudes, and behaviors desirable of an entry level technician;

5) strive to supply/loan/borrow from other colleagues most of the reagents/equipment necessary to effect the protocol if unavailable at the college;

6) test the protocol out before teaching it, be willing to modify its written format (and any ancillary materials including background information and quizzes) in consultation with the coordinator so that it can be improved prior to distribution of a final edition to students, and make it available to students at least one week in advance of carrying it out in class;

7) prioritize one's teaching dates so that the prospect of potential absences during one's teaching stints is minimized;

8) view themselves as a member of a tripartite team of instructors, community college coordinator, and students, instead of a guest teacher for the week (e.g. collaborate with other instructors to present an integrated series of experiences and be interested in the progress of the whole course as evidenced by reading/responding to weekly 1-2 page reports by the coordinator, and attending a July focus group evaluative and planning session);

9) remain available (by email, phone and/or fax) for discussions with students following one's teaching stint;

10) take and respond to constructive recommendations and criticism from community college coordinator and students;

11) be willing to assess oneself, community college coordinator, and individual students (by completion of rating forms, videotaped interviews, and specifically for students, deigning/evaluating quiz/exam tasks & scanning lab notebook entries for the taught protocol), and

12) actively market "good" student graduates for available & appropriate positions in the industry.

Optionally, it is recommended that industry instructors attend:

1) a party in August to informally acquaint oneself with the incoming class of students;

2) a meeting they arrange with fellow instructors teaching before or after them to further promote/insure course continuity;

3) a class session or two before their stint to acquaint themselves with the particular students and learning/teaching environment;

4) presentation by students on research seminars they attend; and

5) participate in mock interviews at the end of the course.

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procedures and material formats to enhance the continuity of the various modules throughout the course.

Before the classes begin, the faculty coordinator, industry instructors, and students are all required to sign a "Credo of Responsibilities" detailing the requirements for the course. (*See exhibit 3I.*) In introductory classes students tour local companies where they observe their instructors working. They also learn about career opportunities, job hunting strategies, and techniques. They learn Good Laboratory Practices (GPA's), and engage in a series of labs focused on various biotechnology experiments, techniques, and knowledge. The faculty coordinator typically directs the first 15 to 20 minutes of each session to provide continuity and to focus on related topics, such as current national and local developments in biotechnology, available jobs, upcoming seminars and symposia, assignment deadlines, and review of past and upcoming protocols. The coordinator supports the industry instructors by highlighting conceptual and methodological points, assisting with laboratory experiments, and ensuring course continuity.

Classes usually include a laboratory experience, led by an industry instructor, followed by an analysis of the conceptual underpinnings of the activity. Students are then assessed on their assimilation of the experience. This assessment sometimes takes the form of work-based scenarios that instructors create from their own work experience, and require students to perform using their skills and knowledge. (*See Assessment section for an in-depth description of assessment methods used.*) Instructors often supply the materials, equipment, and resources required for their classes. Usually instructors teach alone, but occasionally instructors from different companies will lead a class together. Classes run for four hours, three times a week in the evening to accommodate the industry instructors' and many students' work schedules.

These are the advantages of having industry instructors teach much of the course:

- *Cost effectiveness because instructors usually supply the equipment and materials needed for classes;*
- *An advanced level of learning for students, since teachers bring state-of-the-art equipment and methods into the classroom;*
- *Contextualized learning for students from instructors who can serve as role models;*
- *Increased marketability of students because the course provides opportunities for networking with industry representatives;*
- *The development of an interactive networking among education institutions and the industry;*
- *The freedom of the faculty coordinator to deal with issues such as assisting industry instructors with pedagogical development and coordinating different instructor teaching styles;*

Exhibit 3I: Student Credo of Responsibilities

Students in BIO 206 should:

I. Philosophically endorse the concept that a one or two year community college program can effectively prepare students for entry level employment in the biotech industry.
II. Meet prerequisites of the course.
III. Attend a party in August (i.e. before the course begins) to meet fellow students and industry instructors.
IV. Purchase/obtain necessary supplies such as safety glasses, lab coat, lab notebook, and textbooks.
V. Practice good time management, schedule study time, writing time and breaks (i.e. have good organization/study skills). Maintain a consistent study & assignment pace instead of a "work-in-spurts" attitude.
VI. Dedicate one area in your home as study space.
VII. Realize that the course is only one semester long and that the intense workload associated with the course (10-20+ hrs per week) lasts for only a finite period. Make sure you can dedicate yourself to this class.
VIII. Come to class prepared by reading the protocols, assigned literature, and maintaining the lab notebook on a daily basis. Expect a quiz on the first day of each new protocol.
IX. Get along with many different types of people. Be friendly and open. View oneself as part of the family—community college coordinator, students, and industry instructors.
X. Make oneself visible to industry instructors by showing preparedness and interest in biotech. Interact with the industry instructors to show them you know what you are doing.
XI. Not expect that each and every concept will be grasped quickly; be patient and it will "click."
XII. Realize that the program has a reputation for being intense; even if a particular activity or assignment seems abstract in its benefit, completing ALL the work by the assigned deadlines will afford you a desirable reference from Dr. Singer as well as earn you a reputation among the instructors as a hard worker.
XIII. Prioritize your obligations to avoid being tardy or missing class when at all possible.
XIV. Understand that the industry instructors are there to directly help—not hire.
XV. Receive and make use of instructors' and coordinator's constructive criticism/advice/comments through their written evaluations. Be understanding of critiques and make improvements towards attitude, work and ethics.
XVI. Assess oneself and promptly communicate any concerns and recommendations to the Coordinator.
XVII. Evaluate each instructor within one week of his or her final teaching session.
XVIII. Prepare for and attend seminars and company tours.
XIX. Learn something new and exciting, and have some fun.
XX. Utilize BIO 206 grads for job leads, encouragement, etc. (i.e. take advantage and become part of the BIO 206 "network").
XXI. Upon graduating from the program and obtaining employment, continue to promote BIO 206 and your classmates; they may be in a position to assist you in the future.

- *Opportunities for industry instructors to screen and recruit talented students as future employees.*

In 1995 the course facilitator began to assist educators and other nearby community colleges in establishing courses modeled on the one at SDCC. In 1995 a course was developed at Miramar College. In 1997 a scientist from the Salk Institute created a course at Palomar College and in 1998 industry-based instructors were recruited for a course at Southwestern College. Now, with a consortium of four colleges, more students in the San Diego region are able to enroll.

In spring of 1999 a new course, Biomanufacturing Technology, was offered at SDCC. Students learned Good Manufacturing Practices (GMP's), quality System Regulations, and developed knowledge and skills required to enter a range of production occupations. This course was developed to meet the growing need many San Diego-area bioscience companies have for manufacturing technicians. A number of products are moving from the development stage to the approval-for-production stage.

Contra Costa College - *a path-breaking capstone course, utilizing practitioners from local industry as course instructors*

Contra Costa College, located in San Pablo, California, was the first community college to design a biotechnology course, Biotechnology Instrumentation, taught primarily by practitioners from industry. The capstone course uses protocols from area companies as guidelines, as well as donated "wet" laboratory materials and some equipment and consumables. The bioscience skill standards are also used as a guide for evaluating and assessing student progress and skill/knowledge mastery.

The course has received funding from the Carl Perkins Act (U.S. Department of Education) for Tech Prep, the Job Training Partnership Act for work-site training and targeting nontraditional students, and the Center for Science Excellence (U.S. Department of Defense) for course development and operation.

The biotechnology program director/instructor is assisted by an advisory board, including representatives from area bioscience employers. The board members help design and update the curriculum, and many of them teach part of the course. Among the area employers providing class instructors are Berkeley Antibody, Inc., Genentech Corporation, Lawrence Berkeley National Laboratory, Perkin Elmer, Berlex, Bio-RAD Laboratories, Applied Biosystems, Berkeley Antibody, Steritech, Inc., and the Bay Area Bioanalytical Laboratory.

The goal of this rigorous course is to prepare students for employment in the manufacturing/ production area of work in Bay Area biotechnology companies. Toward that end, the course stresses

- hands-on experience with laboratory instruments;
- proper documentation of work;
- precision in laboratory applications;

- utilizing knowledge of industry experts who teach methodologies used in their laboratories;
- perfecting writing skills;
- preparing job resumes and job interview skills.

Students are required to keep laboratory log books, which are checked and graded periodically. They also must write project reports, which are graded and compiled into the students' portfolios. Laboratory performance and class attendance are also monitored and evaluated. The course syllabus includes extensive and precise directions for what the laboratory log books and project reports should contain and the laboratory responsibilities of students.

The capstone course requires prospective students to have had at least one and a half years in either biochemistry or biotechnology at the high school or community college level. The students are also required to demonstrate good communication and computational and problem-solving skills.

Students in the course participate in internships in area bioscience workplaces. Program graduates have been employed by more than 20 Bay Area companies in positions such as research technician, senior production associate, fermentation operator, production technician, laboratory assistant, and production chemist.

Contra Costa College also holds professional development workshops for faculty. Local vendors and industry instructors help provide instruction at the daylong workshops. Attendees include secondary and postsecondary instructors, community college students from several campuses, and technicians from private industry.

EXAMPLE

Project SMART - *involving small- and medium-sized businesses in all facets of an education-to-employment program*

In 1991 Cleveland's Youth Opportunities Unlimited, Inc. (YOU) worked with Education Development Center, Inc. (EDC) to develop Project SMART. Project SMART is an innovative school-to-work program focusing on advanced manufacturing and related technologies.

The project coordinators had a direct connection to small businesses because of the parent organization, YOU. Ninety percent of YOU's 500-employer network were small and mid-sized businesses. Taking advantage of this resource, Project SMART recruited many of these businesses into its school-to-work program.

Recruiting and engaging small and medium-sized businesses is a labor-intensive effort, based on developing personal relationships and trust among many partners. Throughout the process, employers knew they were taking part in an important, well-supervised initiative. They were clear about everyone's roles and responsibilities. Employers were asked to participate in substantive activities, and their comments and suggestions were used in the program's design and development.

Project SMART's 8 to 10 member Design Team created a process to reflect the business culture:

- Meetings were clearly focused and well-organized with a written agenda;
- Action steps were identified for work done outside the meeting time;
- Meeting notes were sent to all participants in a timely fashion;
- Employers formed personal relationships with the project's employer liaison and knew whom to call for information or problem resolution.

Employers played an active and important role throughout the entire project:

- Providing valuable information on the skills and information STW students would need to be successful manufacturing technicians; these were developed by EDC and YOU staff into skill standards;
- Drafting agreements outlining the roles and responsibilities of school and business partners;
- Involving frontline workers from two dozen local companies in writing 45 scenarios containing potential problems that STW students might need to solve in their first several years of employment;
- Hosting field trips, designing shadowing opportunities and producing a booklet of companies taking part in the project, with a list of available jobs and required skills.

EXAMPLE

Stratagene Cloning Systems, Inc. - *a growing company committed to assisting K-12 schools and colleges in its vicinity*

Stratagene Cloning Systems, Inc, a life sciences research institute located in La Jolla, California, has created a division within the company devoted to assisting educators in the life sciences field. The Educational Materials division brings affordable technology to classrooms by providing technical information, assistance, and supplies. Stratagene provides educational materials in kits that include protocols for conducting a number of experiments with DNA, and other related activities. All kits include a procedure manual in both print and electronic (Mac or PC) formats to enable the instructor to make alterations to the experiments or evaluation questions. The company provides a free catalog that describes their different kits, as well as a toll free number that links people directly with a Stratagene scientist who will answer any questions.

Training workshops and career talks are also available through the company's Educational Materials division. Stratagene provides an expert who visits schools to

- provide information about careers in biotechnology and the education programs available to prepare students for entry into the industry;
- give input on the design of lab facilities in schools and colleges;
- provide information about what skills students need to work in biotechnology;
- lead free workshops for teachers on the basics of biotechnology for use in their classrooms.

Stratagene also distributes a free newsletter filled with biotechnology information of interest to educators. The newsletter includes protocols for use in classrooms, news about upcoming conferences/workshops, teaching hints, and product update information. The newsletter also highlights internet sites useful to educators. Stratagene is also developing a similar education division in Austin, Texas, where it is constructing a manufacturing plant.

Biopharmaceutical Technology Center Institute (BTCI), Promega Corporation - *partners with local education institutions to provide a variety of programs for students and teachers in grades 5–12*

With the support of a grant from the National Science Foundation, The Biopharmaceutical Technology Center Institute (BTCI) and Promega Corporation have partnered with Madison Area Technical College (MATC) and the University of Wisconsin at Madison to develop and operate four programs to improve middle school and high school science education. These programs are as follows:

- *Dane County Biotechnology Education Consortium,* offerings in-service training and technical support for high school teachers;
- *Biotechnology Field Trips*, a series of lab activities, including discussion of careers at Promega and a tour of company facility*(see exhibit 31)*;
- *Science and Technology Program*, "A Celebration of Life" summer program, in partnership with the African-American Ethnic Academy, Inc., geared toward fifth through ninth graders, in which students explore the life sciences using hands-on approaches to the study of science.

With MATC, BTCI is also coordinating curriculum development and disseminating information for the Wisconsin Youth Apprenticeship Program in Biotechnology. This is a two-year program for high school juniors and seniors. The students participate in 10 to 15 hours a week of paid apprenticeships in a company or university laboratory setting, and receive specialized instruction.

Lawrence Berkeley National Laboratory (LBL) - *providing summer workshops for community college students and teachers, and an Internet education program for middle and high school students and teachers*

For years, Lawrence Berkeley National Laboratory, in Berkeley, California, has been providing internships for college juniors and seniors, supervised by practicing scientists at the Laboratory. In partnership with the California Community Colleges, the Laboratory now runs the Community College Initiative, a program to prepare community college students for work in biotechnology. The program is funded by the Department of Energy Office of Health and Environmental Research, through the Ethical, Legal, and Social Implications Program of the Human Genome Project.

The initiative was created by LBL to enhance experiences of community college students involved in two-year certificate and associate degree programs for biotechnology technicians. The primary goal of the program is to encourage students to pursue science, mathematics, engineering, and technology studies; to participate in the state-of-the-art laboratory research; and to gain valuable work experience.

LBL began by holding a three-day meeting of staff scientists, community college instructors, mentors, etc. in order to identify what the community college students should study. Students who have completed their first year of biotechnology studies in a community college participate in a four-week residential program. The students attend an orientation program and then work through a series of realistic laboratory exercises to develop their skills in problem solving, decision making, laboratory techniques, computer, instrumentation, and mathematics. Ethical, legal, and social concerns are integrated into the program. Students learn to identify commonly shared values in the scientific community and increase their

Exhibit 3J: Biotechnologies Field Trips
Academic Year 1999/2000

In response to requests for the opportunity to engage in hands-on activities, BTCI offers Biotechnology Field Trips (BFT) to middle and high school students and their teachers. Designed as a 2-3 hour visit to the BioPharmaceutical Technology Center, field trip experiences include laboratory experiments based on molecular biology techniques and a tour Promega's production facilities. This year's program features three laboratory field trips: **Bioluminescence, Restriction Enzyme Digest and Gel Electrophoresis of DNA, and Immunology**.

Bioluminescence uses click beetle luciferase to demonstrate the transfer of a gene into another species. After a 25-minute slide show about bioluminescence, the participants go into the laboratory to perform a simulated genetic transformation, which transfers the luciferase gene, and the ability to make bioluminescent light, into bacteria. Students will learn about:

- Bioluminescence
- Genetic transformation
- Sterile technique

Restriction Enzyme Digest and Gel Electrophoresis of DNA demonstrates how DNA is specifically cut into fragments by restriction enzymes and then is separated by fragment size on an agarose gel. The participants will use lambda DNA and four different restriction enzymes to prepare four different DNA digestion patterns. Topics discussed will be:

- DNA structure
- Restriction enzyme
- Function and use in cloning
- Principles of gel electrophoresis

Immunology focuses on the scientific use of antibodies to detect proteins in the laboratory. Participants purify antibodies from egg yolks and use them to detect *E.coli* and/or Salmonella proteins on a membrane. Students will engage in activities to aid their understanding of the following:

- Antibody structure and function
- Protein isolation
- Antibody detection techniques

understanding of issues of personal and public concern. The program incorporates information from the national bioscience skill standards, and uses the scenarios in those skill standards as a basis for the learning exercises. At the end of this program, students write a web page final report. Students receive free housing and $200 a week.

Some students return during a second summer for a ten week paid internship. The interns are supervised by a principal investigator and a laboratory staff member (e.g., research assistant, graduate student).

LBL also developed and operates The Internet: Ethical, Legal, and Social Issues in Science project, a science and technology education program for grades 6–12. The project provides access for students and teachers to current scientific research at the national laboratory and other scientific facilities through Internet links. (*See Appendix B for website listing.*) Students and teachers learn about this research and its implication in daily life. Modules explain the background history and nature of each science project, as well as discuss the ethical, legal, and social issues raised by this research and the results.

Extensive reference information about sites and resources involved in similar research is also provided. Student activities offer a variety of learning and program assessment tools. Accessing information through these modules enables students and teachers to develop critical and analytical thinking, scientific inquiry, and problem-solving skills.

The program was designed in accordance with the American Association for the Advancement of Science Benchmarks for Scientific Literacy.

EXAMPLE

Reality Check - *a partnership of corporations and trade associations that provides information to students about careers in agricultural biotechnology*

Several corporations and trade associations with agricultural biotechnology divisions provide career information to high school students through an activity called Reality Check. Six companies or trade organizations have agreed to take calls or reply to written requests from students about career information. The objective of this activity is to help students gain an understanding about a particular agricultural biotechnology occupation. Students learn about the work environment, day-to-day duties, experience needed, and approximate salary range for various biotechnology occupations. Students complete a contact form and share the information with classmates. (*See exhibit 3K.*) The completed forms are then used to compile an Agricultural Biotechnology Job Opportunity Notebook which is kept in the classroom as a reference or donated to the career guidance department.

Agricultural biotechnology companies and trade associations participating in Reality Check follow:

Companies

American Cyanamid Agricultural Division
Human Resources Department
Research and Development
Princeton, NJ

Trade Associations

Biotechnology Industry
Organization (BIO)
1625 K Street, NW, Suite 1100
Washington, DC

Exhibit 3K: Reality Check: Employer Information Request Form

Contact Form:

*Name:*________________________ *Company of Organization:*___________________

*Tel:*__________________________ *Date of Inquiry:*___________________________

*Job Title:*______________________ *Degree(s) Required:*________________________

*Describe the Job's Work Environment:*____

*Describe some of the day-to-day duties required in this job:*________________________

*Is previous experience required for an entry level position? If so, describe the experience needed:*____

*What is the approximate salary range for an entry level position?*___________________

Companies

Ciba Seeds
Human Resources
Greensboro, NC

Monsanto Company
Human Resources
Research and Development
St. Louis, MO

Trade Associations

North Carolina Biotechnology
Center
Research Triangle Park
Raleigh Durham, NC

Pioneer Hi-Bred International, Inc.
Employment Manager
West Des Moines, IA

3

How Can a Program Operate Smoothly, and Why Is a Paid Third Party Essential?

Once a program is developed, it requires continual work to keep the curriculum and pedagogy relevant; assist teachers, work-based instructors, and other providers; coordinate the school and work-based learning; provide support to students; resolve problems; and perform many other operational tasks. This requires a great deal of ongoing work by program administrators and financial support. In this section we present examples of programs that have developed strategies for maintaining themselves and discuss the need for adequate personnel to do this.

How Skill Standards Can Help

Skill standards, which are kept up-to-date with industry needs, provide a rudder to help keep education-to-employment programs on course. They continuously provide benchmarks to assess the progress of students' learning. These benchmarks also measure the ability of the program to provide the learning experiences students need to master the knowledge, skills, and behaviors required to advance to further education or qualify for entry into the workforce. Successful program administrators, teachers, and work-based supervisors report that continual reference to a set of skill standards helps them refine and revise, as necessary, curriculum, instructional strategies, and assessment methods.

Following are a few examples of programs that have been developed and honed, with the leadership of strong directors, much experience, and financial support from industry and government, to become models of smooth and successful operation.

CASE STUDY

New Hampshire Community Technical College (NHCTC)

The biotechnology program at New Hampshire Community Technical College, in Portsmouth, New Hampshire, provides a thorough example of program development, including (a) three different level programs; (b) strong involvement of area industry; (c) well developed articulation with both high schools and four year colleges; (d) a classroom operating and designed as a "virtual workplace," which also exists on the Internet for distance learning; and (e) a curriculum designed to meet the national bioscience industry skill standards.

Most students in the program are adults, returning to school for additional training to upgrade job skills and employment level. There is one full-time faculty member who teaches the courses specific to biotechnology, including courses critical to the industry. Teachers from the Departments of Arts and Sciences and Veterinary Technology teach the program's other courses.

Standards-based programs in The Virtual Workplace (in the classroom and online), with strong industry connections and articulation with high schools and four-year colleges

There are three levels of biotechnology programs within the college, each of which requires the completion of two 6-credit cornerstone courses (a total of 12 credits):

- A certificate in biotechnology (total of 10 credits needed);
- A diploma in biotechnology (total of 33 credits needed);
- An arts and sciences degree in biotechnology (total of 64/65 credits needed), with three courses specific to biotechnology required (two cornerstone courses and a lab animal science course).

Additionally, summer workshops are held in biotechnology for local area teachers in which teachers learn about careers in biomanufacturing; discovery research and process development; the skills, knowledge, and attributes necessary for these occupations; and instruction related to the use of tools and processes specific to the industry.

The biotechnology program at NHCTC has strong linkages to area industry, baccalaureate institutions, and high schools. The program's advisory board members are from biotechnology workplaces, which donate equipment and supplies to the program. Industry representatives frequently give guest lectures and head classes. Program graduates are mostly employed by local companies and are hired part-time to refine and develop protocols and Standard Operating Procedures (SOPs), and work as laboratory technicians/ teaching assistants and industry experts.

The University of New Hampshire (UNH) has a written agreement with NHCTC under which credits for most of the biotechnology arts and sciences degree are transferable to UNH's Department of Molecular, Cellular, and Developmental Biology. The Rochester Institute of Technology will accept transfer credits in their Department of Biology.

NHCTC has created a "mirror site" with Milford High School in New Hampshire with a wet-lab and center, outfitted with biotechnology equipment and tools. A hands-on biotechnology curricula has been developed for the 10th, 11th, and 12th grades. This program has served as a model for other area high schools. NHCTC has also increased the awareness of biotechnology by inviting other area high school students to spend a day at the school learning laboratory techniques, such as extracting and spooling DNA from cow thymuses, or doing human PCR fingerprinting.

CASE STUDY CONT'D

The NHCTC program has set up a 2,500-square-foot space called *The Virtual Workplace. The Virtual Workplace* includes a work space with tools and equipment that are found in an integrated biotechnology company, where the students can carry out discovery research, process development, and the manufacturing and production of protein products. The students work in teams, and each individual student assumes responsibility for a specific knowledge area and the operation of specific tools and equipment. The individual student then teaches the rest of the group about his/her knowledge area.

Students work with research protocols and manufacturing SOPs that incorporate the skills and knowledge necessary to meet the skill standards. An Internet version of *The Virtual Workplace* enables people in companies or outlying areas to take the course via distance learning. The Internet version is also used as an interactive test book and laboratory manual for the real-time classes. NHCTC is piloting a version of each of the two cornerstone courses in which students are online for one half of each week's class and in real-time for the other half.

The NHCTC program uses the national bioscience and agricultural biotechnology industry skill standards to design, structure, and assess all of the lessons and laboratories developed for the biotechnology course. (*See exhibit 3L.*)

The program has received grants from: the National Science Foundation for equipment to establish a world class biotechnology education and training facility; the Fund for the Improvement of Post Secondary Education to develop the concept of *The Virtual Workplace*; and the Alfred P. Sloan Foundation to place an Ethics Enhanced Biotechnology Certificate on-line for technicians-in-industry.

EXAMPLE

Madison Area Technical College (MATC) - *a well-established program that provides thorough biotechnician education, with project-based learning, individualized internships, and good teamwork by experienced faculty*

Madison Area Technical College, in Madison, Wisconsin, has been offering a two-year biotechnology program since the late 1980s. The program's goal is to give students excellent and comprehensive preparation for immediate entry into the biotechnology industry or related work. The students take courses that all maintain a technology focus. For example, when taking cell biology, the academic component focuses on the biotechnology industry, and how cell biology can be incorporated into the biotechnology industry.

The curriculum emphasizes project-based learning, which is meant to prepare students for the type of work they will do when employed. Because the program has been operating at least 10 years, and every faculty member is fully aware of all the courses in it, the program has been fine-tuned into a smoothly functioning, highly successful endeavor.

The MATC program focuses on 20 basic procedures for use in a work laboratory. Included in these procedures are numerous academic, technical, and generic employability skills that MATC students must master. MATC has correlated these "core competency" skills with

Exhibit 3L: Biotechnology Experience I - Research

MODULES	DATE INTRODUCED	TRAINING ELEMENTS	BIOSCIENCE SKILLS	CRITERIA	DATE DUE	GRADE
MODULE 1-						
Research Overview:	26-Aug	**BIOTECHNOLOGY OVERVIEW:**				
		Read articles on the biotechnology industry.	L2 Research literature	Research Paper	9-Sep	AWARE
			N5 Read technical literature			
		Produce double spaced, 500 word document with references.	K6 Process information using computers			
	26-Aug	**TECHNICIAN'S ROLE:**				
		Read articles on technician's role in industry.	L2 Research literature	Research Paper	9-Sep	AWARE
			N5 Read technical literature			
		Produce double spaced, 500 word document with references.	K6 Process information using computers			
	26-Aug	**LABORATORY SAFETY:**		Quiz	11-Sep	AWARE
		View Video Tapes:	H1 Follow Regulations: FDA GLP's			
		Practicing Safe Science (HHMI)	H2 Follow Regulations: OSHA			
		Safety in the Research Laboratory (HHMI)	H8 Follow state and local regulations			
		Laboratory Safety and Health (K&A Audio)	H9 Follow industry and professional regulations			
		Orientation to Laboratory Safety (Savant)	G1 Maintain and follow chemical hygiene plan			
		Preventing Contamination (Savant)	G2 Follow universal precautions for biological pathogens			
		Laboratory Hoods (Savant)	G3 Use protective equipment			
		Electrical Safety in the Laboratory (Savant)	G5 Observe rules of electrical safety			
		Material Safety Data Sheets (Savant)	G7 Handle, contain, and dispose of hazardous materials			
			G8 Maintain safety equipment			
			G9 Observe procedures for the safe use of instruments			
	28-Aug	**TOOLS OF THE TRADE:**				
		Become equipment technician for one piece of lab equipment	N5 Read technical literature			
		Read, Consult others about the equipment.	F3 Perform or schedule preventive maintenance			
		Read about same equipment from other vendors.	K1 Interact with vendors, colleagues, clients			
		Understand the operation of the equipment.	F1 Check calibration and perform systems diagnostics			
			F2 Validate or confirm vendor products (e.g. equipment)			
			F7 Maintain equipment logs			
		Write SOP for operation of the equipment.	K3 Write or update procedure manuals for validation	SOP for Equipment	first time used	EXPERT
		Make oral presentation to class on equipment.	K5 Make oral presentations	Oral Presentation	first time used	EXPERT
			F9 Label equipment and facilites			
	28 Aug and 4 Sep	**PIPETTING:**				
		Learn to use small volume micropipettor (DNA Science).		Show Results	28-Aug	AWARE
		Learn to use large volume micropipettor (DNA Science).		Show Results	28-Aug	AWARE
		Learn to use 1-25ml sterile standard pipets (DNA Science).		Show Results	28-Aug	AWARE
		Rainin Pipettor Presentation-Susan Dancewicz	F1 Check calibration and perform systems diagnostics	Vendor Presentation	4-Sep	AWARE
	28-Aug and 4-Sep	**REAGENT, BUFFER, SOLUTION PREPARATION:**				
		Organize tools and compounds.	D1 Organize compounds			
		Perform calculations (weight/volume/concentration)	J2 Perform calculations	Quiz	11-Sep	AWARE
		Prepare reagents, buffers, and solutions	D2 Prepare, reagents, buffers, and solutions	Show Results	4-Sep	DEMONSTRATE
		Maintain laboraoty notebook	L3 Maintain laboratory notebook	Show Results	4-Sep	AWARE
			E3 Date, label, store supplies and/or reagents	Show Results	4-Sep	AWARE
			G7 Handle, contain, and dispose of hazardous materials			
MODULE 2-						
Properties of DNA	9-Sep	ISOLATE AND SPOOL DNA (MODERN BIOLOGY)	B1 Follow protocol, test procedure, SOP			
		Obtain calf thymus.	B2 Obtain raw material			

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those identified in a number of national skill standards related to their program. (*See exhibit 3M.*) At the end of the first semester of the second year, students must take and pass a performance-based exam on the 20 procedures in order to qualify for participating in an internship.

The internship takes place during the second semester of the second year, with students working 12 hours a week. The internships are tailored mostly toward students' own interests, and take place at local work sites such as biotechnology companies, university laboratories, and government wildlife programs. Some students carry their work-site experience over into the classroom by working on optional projects that directly relate to their internship.

This program is designed to give students strong, basic skills, which include calibrations, chromatography, solutions and buffers, GMPs, and quality standards, etc. The courses are created to support these fundamentals and to make sure that students are fully competent in the necessary skills required by the industry. This program is an excellent example of one that focuses explicitly on preparing students for immediate entry into work. However, it also helps them develop the basic academic and cognitive skills they will need if they decide later to further their education and earn higher degrees required to advance in their careers.

EXAMPLE

Scripps Ranch High School - *a comprehensive high school oriented around career majors*

Scripps Ranch High School, located in San Diego, California, has developed a structure that introduces students in grade 9 through 12 to work and careers. The schools program stresses strong academics, use of modern technology, a wide variety of electives, and the integration of academic and career curricula.

The four-year plan—currently undergoing revisions and adaptations—includes:

Grade 9: Career Interest Inventories

- students are helped to identify careers and work that fit with their interests and abilities through the use of a series of tests and surveys, including the Career Ability Placement Survey (CAPS), the Career Occupational Preference System (COPS) and the Career Orientation Placement and Evaluation Survey (COPES). These tests measure abilities, interests, and values by means of a series of timed and untimed tests and inventories;

- students receive information about where their interests lie and about careers in their fields of interest;

- educators review the tests results with the students.

Exhibit 3M: Employability and Workplace Skills Related to Skill Standards Projects

Workplace Skills	ACS CLT	ACS PTO	EDC Bio	FFA Agbio	MATC BLT	CORD HHMT	MATC Core
1. Apply quality principles in all aspects of work.	X		X		X	X	
2. Participate as a team member.	X	X	X	X	X	X	X
3. Participate in team meetings and team discussions.	X			X	X	X	X
4. Value the opinions of others.	X				X	X	X
5. Maintain good problem-solving skills.	X	X	X	X	X	X	X
6. Have good interpersonal skills.	X			X	X	X	X
7. Demonstrate responsibility for fellow workers' safety and health.	X	X		X	X		X
8. Think critically.	X	X	X		X	X	X
9. Value diversity.	X	X		X	X	X	X
10. Prioritize work.	X	X	X	X	X	X	X
11. Demonstrate ethics (in reporting data.) (all aspects of work.)	X	X	X		X	X	X
12. Coordinate several tasks simultaneously.	X	X	X	X	X	X	
13. Make observations and anticipate needs.	X			X	X	X	X
14. Make decisions.	X				X	X	X
15. Be flexible and willing to listen to others	X				X	X	X
16. Pay close attention to details	X	X			X	X	
17. Keep accurate records	X			X	X	X	
18. Continue to take training to upgrade skills	X	X	X		X		X
19. Observe trends.	X				X	X	X
20. Be flexible.	X					X	X
21. Work under pressure.	X	X			X		
22. Have high tolerance for short deadlines.	X				X		
23. Work independently.	X	X		X			
24. Be willing to put out extra effort, as required	X						
25. Provide customer service	X		X		X	X	

ACS CLT = from American Chemical Society Chemical Laboratory Technician Standards
ACS PTO = from American Chemical Society Process Technical Operators Standards
EDC Bio = from EDC Bioscience Skill Standards
FFA Agbio = from FFA Agricultural Biotechnology Technician Standards
MATC BLT = from Madison Area Technical College Biotechnology Lab Technician Program Competencies
CORD HHMT = from CORD Hazardous Materials Management Skills Standards
MATC Core = from Madison Area Technical College Core Competencies for all students

Grade 10: Currently in the planning stage, it will include activities that build on the introductory career exploration begun in grade 9.

Grade 11: Job Shadow

- the school surveys local businesses, parents, and other resources to find professionals for students to shadow for an entire day;
- students select occupations and careers to learn about based on their interests, as identified in the test and surveys they took;
- the school matches up students with professionals who work in their areas of interest;
- educators prepare the students by discussing appropriate dress and behavior, exploring workplace situations, and helping students develop questions they can ask their mentors;
- the students spend a whole day job shadowing;
- on return, students discuss their experiences and write thank-you notes to the people they shadowed;
- the teachers review the students' writings to ensure they have complied with the requirements of the shadowing experience;
- the entire job shadowing experience, including preparation, the shadowing experience, and follow-up work, is a 6 to 8 week experience.

Grade 12: Graduation Portfolio Requirements
These include:

- test results, such as those from the Capes, Copes, and Cops surveys;
- a reflection paper on a chosen career to explore. Students interview someone in a career they have chosen to investigate, and conduct research about the career by studying written and online materials. Written information they study may include required education, what about the career interested the student (the work, the work setting, etc.), salary ranges of jobs in that career area;
- Students give a 15-minute presentation, identifying and solving a problem often encountered in the career they have studied, and discuss how they might try to resolve it. The presentations are usually accompanied by audio/visual material.

Scripps Ranch also maintains some school-to-career Integrated Curriculum Projects, funded by a Carl D. Perkins Grant. Two examples are:

1. Teaching programs in world languages: third and fourth year students of Spanish, French, German, and Philipino go into elementary school for 20 minutes twice a week to teach elementary students a block of each language, using the child development input from the Consumer and Family Studies.

2. KidSat: utilizing existing space technology and the electronic network available to provide visual images of the earth taken from space, a cadre of students will become capable of running, maintaining, and installing the necessary electronic hardware to access and distribute the data stream from a shuttle mission.

Scripps Ranch maintains four computer laboratories, each with 36 work stations. The school also has a completely automated library media center, with on-line public access and CD-ROM database and software, and an electronic resource library. It also has a sophisticated television studio, with multi-media production capabilities and computer editing of audio and videotapes.

EXAMPLE

City College of San Francisco (CCSF) - *a well-developed two-year college program articulated with high schools and four-year colleges*

The City College of San Francisco (CCSF) biotechnology program is designed to provide students with hands-on skills for careers in the biotechnology industry. CCSF offers a certificate through the college's biology and chemistry departments. Students obtain their biotechnology certificate in two years, with the option of also taking general education courses to obtain an arts and sciences degree. CCSF's biotechnology program provides students with a theoretical background and hands-on laboratory skills in the chemistry and molecular biology required for entry-level technician jobs in the bioscience industry.

The CCSF program has strong relationships with local industry, baccalaureate institutions, and high schools. While the program does not require a work-based learning component, a biology work experience is offered as a technical elective. Most students choose to participate in an industry internship, many of which take place at Lawrence Berkeley National Laboratory, in Berkeley, California. Industry scientists regularly participate in laboratory instruction at the college as well. CCSF's biotechnology program is articulated with Hayward State and San Jose State Universities, providing opportunities for students to transfer credits into a university bachelor's degree program. The students may begin the CCSF program while in high school by enrolling in a survey course, Briefing in Genetic Engineering. Also, local high schools in the area now offer a science course called Applied Biotechnology. The tech-prep link between local high schools and CCSF have created opportunities for high school teachers and community college faculty to work together to provide a career path for high school students into the biotechnology industry.

CCSF is the prime contractor on a recently awarded grant from the National Science Foundation's Advanced Technology Education Program to develop a national bioscience education center. Other partners include community colleges in California, New Hampshire, North Carolina, Wisconsin, all of which are described in this manual.

EXAMPLE

Altus High School - *a 50-year-old program in agricultural biotechnology that is continually updated by the joint efforts of representatives from the agricultural industry and educators*

Altus High School, located in Altus, Oklahoma, has designed a school-to-work program that is continually updated to take the latest developments in agricultural technology into account. In existence for more than 50 years, the program operators are constantly looking for ways to improve delivery and quality, including the incorporation of academic and technical education standards into the curriculum. Altus maintains a three-stage process developed by the local board of education as a means to update the program.

1. Data Collection: This stage involves various groups working independently to provide baseline data for the planning stage.
2. Planning: The groups collaborate and continue to interact through the implementation and evaluation stage.
3. Implementation and Evaluation: The groups implement the program and conduct both formative and summative evaluation activities, based on integration of academic content, technical skills, and workplace expectations.

This school-to-work model was designed specifically for Altus High School. Students in the program participate in a student-process scenario that includes the following steps:

- The student completes a student-interest inventory;
- The results of the inventory provide information to assist in the enrollment process as a means to determine the student's career aptitudes;
- The student is matched with a workplace mentor and interviews with the mentor when school begins in the fall;
- The student is then matched with a work site for a total of four days of experience in a workplace that promotes school-to-work programs—one day a week, every other week;
- At the end of the semester, students are given a skills certificate based on the results of a school and workplace mentor assessment;
- Each student develops a personal portfolio to use when seeking employment;
- The student, parent, mentor, and school representative sign an agreement outlining the roles and responsibilities required of each individual. (*See exhibit 3N.*)

The program integrates several academic departments with the technical education aspect of the program. This involves a great deal of support from industry and cooperation among the agriculture, math, English, and science departments. The program has received the Secretary of Education's Awards for Outstanding Vocational-Technical Education programs. The award recognizes excellence in local school-to work and vocational-technical education programs, services, and activities.

The Need for a Third Party: The Role of the Program Director/Coordinator

Unless a program receives substantial funding from a corporation, state or local government, or a grant that supports a full-time staff of one or more people, all of the duties of a program director or coordinator must be carried out by an extremely dedicated teacher, employee, or other fully employed person. In some cases, teachers are released from some of their teaching responsibilities and paid part-time by their school or education system to perform coordination activities. In other cases, teachers may secure a grant to "buy out of" some of their teaching schedule to spend more time on program coordination. Some super-human people actually work simultaneously as teachers or employees, as well as program directors and coordinators.

From our observations and information collected from the field, we believe it is extremely difficult for one person to do all of the work required to administer and coordinate all aspects

Exhibit 3N: Job-Shadowing/Mentoring Agreement

School to Work

This agreement is between ____
School District Name

and ____________________ ____________ ________________________
Mentor Name Fein No. Student Name

____
Social Security No.

The undersigned parties agree to enter into a work-site learning program for the purpose of educating the student named above in the ______________________ industry/profession.
Type

The School-to-Work partnership has been approved to operate a work-site learning program and will over see implementation of this agreement.

The work-site learning program will begin on ______________ and be completed on ______________
Date
Date

Upon successful completion of this program, the school-to-work student shall be awarded a skills certificate by the school district named above.

A detailed schedule is attached that identifies desired learning experiences for the student.

The individual schools in the partnership may void this agreement upon request of the school-to-work student, the parent, the school district, or the mentor after a satisfactory showing of good cause as determined by the school site administrators.

The parties Agree to the Following Responsibilities in the Implementation of this Agreement:

The School-to-work Student agrees to:

- meet the academic and attendance requirements established by the local school-to-work partnership,
- observe company rules and other requirements identified by the mentor,
- participate in progress reviews scheduled with mentors, school personnel, and parents or guardians,

(continued exhibit 3N)

- observe all school rules that apply to students when they leave campus including transportation, discipline, classwork, etc;

The School-to Work Student's Parent or Guardian agrees to:

- support the school-to-work student in meeting the requirements of the program;
- work with the school to ensure that transportation to and from the work site is provided;
- participate in progress reviews scheduled with mentors, school personnel, and the school-to-work student.

The School District agrees to:

- support the school-to-work student in meeting the requirements of the program;
- work with the school-to-work student's parent or guardian to ensure that transportation to and from the work site is provided;
- participate in progress reviews scheduled with mentors, the school-to-work student, and his/her parent or guardian;
- monitor the academic progress of the school-to-work student to ensure that high school graduation requirements are met;
- award a skills certificate to the school-to-work student upon successful completion of the program;
- provide liability coverage for the school-to-work student for all hours worked.

The Mentor agrees to:

- provide a work-based learning experience for the length of the agreement;
- instruct the school-to-work student in the competencies identified in the outline of the four-day work experience provided for this program;
- attend training related to the program;
- participate in progress reviews scheduled with the school-to-work student, the student's parent or guardian, and school personnel

(continued exhibit 3N)

The parties to this agreement shall also comply with the following assurances:

A. School-to-work students must be provided with adequate and safe equipment and a safe and healthful workplace in conformity with all health and safety standards of federal and state law.

B. No employer shall hire a school-to-work student who will displace any currently employed worker (including a partial displacement, such as a reduction in the hours of non-overtime work, wages, or employment benefits).

C. No work-site learning program shall impair existing contracts for services or collective bargaining agreements. Any work-site learning program that would be inconsistent with the terms of a collective bargaining agreement shall be approved only with the written concurrence of the employer involved.

D. No employer shall hire a school-to-work student when:

    1. Any other individual is on temporary layoff, with the clear possibility of recall, from the same or any substantially equivalent jobs, or

    2. The employer has terminated the employment of any regular employee or otherwise reduced it's workforce with the intention of filling the vacancy so created with a school-to-work student.

E. All other safeguards that are identified by the State and Federal Departments of Labor will be honored and observed.

SIGNATURES:

Student: ______________________________ Mentor: ________________________

Parent of Guardian: ____

School Representative: ____

of a comprehensive program, while teaching or performing other work full-time. Even a full-time program director needs an assistant to help do the work required to make a complex program effective. Individuals who have developed and directed programs primarily on their own, invariably have tremendous commitment, great creativity, and a willingness to put in long hours. Most of them have managed to obtain from their schools some paid release time from teaching to spend on program development and management. Most have received grants and other support from federal, state, and local government agencies, foundations, and local corporations.

We believe a successful education-to-employment program must have at least two paid individuals whose total time is dedicated to directing and coordinating a program. One person should serve as program director, the other as a program coordinator and assistant. These are some of the many tasks the individuals will perform:

Director

- Raise funding for program support (e.g., meet with potential funders, write proposals, develop budgets);
- Submit required status reports, financial reports, and other documents to funders;
- Recruit advisory board members;
- Interact with advisory board members and deal with their concerns;
- Set agendas for and lead advisory board meetings;
- Manage the operations of the program, including coordination among the program participants (school administrators, teachers, counselors, employers, supervisors, workers, students, parents, etc.);
- Arrange for and manage articulation among education institutions in the program;
- Help reconcile institutional and cultural differences between employers and educators (e.g., employers' emphasis on meeting bottom line versus educators' emphasis on "seat time," numbers of graduates, higher education or job placements), and other program participants;
- Work with participants to develop policies that allow the program to operate smoothly;
- Work with school administrators and employers to arrange for appropriate professional development for teachers, counselors, and work-based mentors and supervisors;
- Develop relationships with area employers to obtain work-based learning opportunities for students, teachers, and counselors;
- Supervise the program staff and other major program assistants;
- Monitor and track performance of program graduates.

Coordinator/Assistant

- Help provide coordination among teachers, work-based supervisors, and other education providers;
- Help develop manuals and materials for teachers and work-based supervisors, including information, examples, and other aids to assist them with their jobs;

- Help resolve logistical obstacles (e.g., scheduling conflicts, liability for students and teachers at work sites);
- Assist teachers in classrooms by assembling materials for classroom learning, obtaining and modifying (if necessary) real workplace documents for teachers to use, observing classes and providing feedback to teachers, assisting during classes, etc.;
- Help develop work-based learning placements for students, teachers, and counselors;
- Develop standardized forms and packets for student applications to the program and for work-based learning, including descriptive materials about the program or activity and policies, application forms, medical forms, and parent consent forms;
- Help students complete required forms and process them (e.g., submit forms to program director, employer human resource department or other work contact, school administrators);
- Help screen student applicants for program and for work-based learning, and arrange for interviews;
- Arrange for class tours of local work sites;
- Obtain work permits for work-based learning and process them;
- Arrange for appropriate training and work experience for students in work-based learning;
- Visit and observe students at their work sites, and report back to teachers, program director, and others;
- Prepare information packets and arrange for counseling of students going into work-based learning experiences;
- Conduct parent, student, and supervisor orientation and information meetings regarding work-based learning;
- Assist with evaluation and documentation of student performance in classrooms and in work-based learning placements;
- Help teachers maintain student files and records for use when they apply for further education or employment;
- Provide support services to students and their families (such as transportation to work sites, referrals to medical services) to help them remain in the program;
- Assist students with career planning and provide them with relevant reading materials;
- Assist with student transition between education/training and further education and/or work (e.g., writing letters of recommendation, collecting information for portfolios);
- Help arrange for student advancement to further education and/or job placement.

This extensive, yet incomplete list of responsibilities and tasks provides an idea of the great amount of work required to manage and maintain a successful education-to-employment program. The need for paid, full-time staff to serve this connecting third party function is crucial. (*See exhibit 3O.*)

Exhibit 3O: Responsibilities of Biotech Coordinator

Interaction with Instructors:

- Recruiting/Interviewing Prospective Instructors for current & new courses
- Pre-semester meeting to evaluate past year and plan for next year
- Previewing/refining individual protocol & exams (company visits)
- Maintaining a session-by-session chronology and reviewing that chronology of past sessions by an upcoming instructor to remind instructor of post-protocol decisions that will improve teaching stint, as well as coordinator checking written protocol for necessary materials (equipment & literature) needed by students
- Relaying student formative & summative assessment papers (e.g., lab notebook copies, protocol analyses, exam responses (company visits)
- In-class ancillary lab tech; secondary teacher; empathic student; camcorder operator
- Making video snapshots of identified-student-interaction with other students & instructor to assist instructors in evaluation of individual students
- Reviewing instructor impressions of students with instructors at company sites prior to releasing this information to students
- Post-class immediate verbal assessment; end-of-stint written assessment (following collection of numerical/open ended rating form + job function categorization)
- Marketing students and fellow instructors

Interaction with Students:

- Screening prospective students
- Pre-semester meeting
- Coordinator's Corner (Local biotech co. news, job screening, forum to track current & past student job hunting ventures, handout availability including articles to promote job hunting skills, seminar screening, protocol preview & review, review of ancillary curricular materials, forum to "mini-assess" overall class satisfaction with course, announcement of a) visitors in class b)various student deadlines, c) graded assignments & d) availability of instructor evaluation,)
- Leading/arranging special class sessions (e.g., Exams, Seminars, UCSD info retrieval session, Current status of local biotech, Company tours with preliminary co. info, Job hunting skills, Mock Interviews, End-of-course videotaped individual & focus group impressions)
- Attending seminars at research institutes with students
- Evaluation (Lab notebook, Portfolio, Seminars, Mock Interviews, In-class, end-of-class individual & group videotaping)
- Dispensing industry instructor impressions to individual students
- Collation, analysis & evaluation of end-of-protocol and end-of-course student ratings
- Student job placement and tracking (including visitations to companies where graduates work)

Bioscience Workforce Development Center & CACT Responsibilities:

- Consulting with prospective & current incubator occupants
- Consulting with industry and faculty to expand programs
- Obtaining/dispensing donated equipment
- Obtaining institutional and consortial grants
- Consulting with current and prospective community college biotech coordinators inside/outside the district (visitations and log maintenance)
- Consulting with bioscience skills standards groups
- Presentations at City College and conferences

4 How Can a Variety of Populations and Needs Be Served, and How Can Students Be Recruited into the Program?

As discussed in the introduction, education-to-employment programs should be designed to meet the needs of *all* students, whether they plan to proceed directly with further education, go directly into the workforce after graduation, or work for a while before returning to school. Programs also need to exist for out-of-school youth and for adults who have few work skills, need to upgrade their skills for career advancement, or need/want to change careers. In other words, to the greatest extent possible, education-to-employment programs should be designed to serve a variety of populations with differing needs and resources. In addition, recruitment strategies should be developed to reach out to a variety of populations, including people who are traditionally underserved by these programs.

How Skill Standards Can Help

Skill standards can be used to inform prospective students about what they will be learning in a program. If a young student, or an adult who needs to upgrade skills or change careers, is interested in the content of the work described by the skill standards, that person is likely to want to enter a program to acquire those skills. The standards also inform teachers, career counselors, human resource directors, workplace supervisors, and public sector trainers and job placement specialists about how to help their students, supervisees, or clients decide whether or not to enter a program focused on the standards content, if they are qualified to do so, and if the program will help them meet their goals.

This section of the manual focuses on a variety of programs designed to meet the needs of differing population groups, with particular requirements and resources, who want either to enter the workforce directly from the program or to continue with further education and training. We provide program examples for three such groups:

Young students in the school system who have varied needs;
Adult students or out-of-school youth with special needs;
Adults with advanced degrees or incumbent workers in an industry who need further specialized training or experience.

CASE STUDY

CityLab, Boston University School of Medicine

CityLab, at Boston University School of Medicine, is an example of a single institution offering a variety of programs and initiatives that respond to the needs of a diverse community. Although all the students enrolled in the various programs focus on the field of biomedicine or biotechnology, they enroll with differing levels of education and work experience, and have differing goals. The School of Medicine has continually developed

CASE STUDY CONT'D

An institution offering a variety of programs to serve the needs of differing populations in Massachusetts and nearby states

programs to accommodate all backgrounds and all levels of students, and provides opportunities for students to pursue higher educational levels throughout their careers. (*See exhibit 3P.*)

CityLab serves thousands of middle and high school students in Massachusetts, including those with special needs, in alternative education programs, general studies, and advanced placement. One part of the program provides classes of students and their teachers with access to a fully equipped mock biotechnology laboratory. Students can use the facilities either for individual projects or as part of a class. CityLab also operates a full-size bus that is completely outfitted as a functioning laboratory, in which student can conduct a variety of experiments to learn about biotechnology and practice technical skills. The bus transports equipment and materials to schools around Massachusetts and neighboring states and to "satellite" CityLab sites. Students who attend the main CityLab facility or do experiments in their traveling laboratory bus learn about the other educational options offered in the program. CityLab is supported by grants and free to all participants. In addition, funding for substitute teachers is available to enable primary teachers to attend workshops and practice teaching experiments and other activities at CityLab.

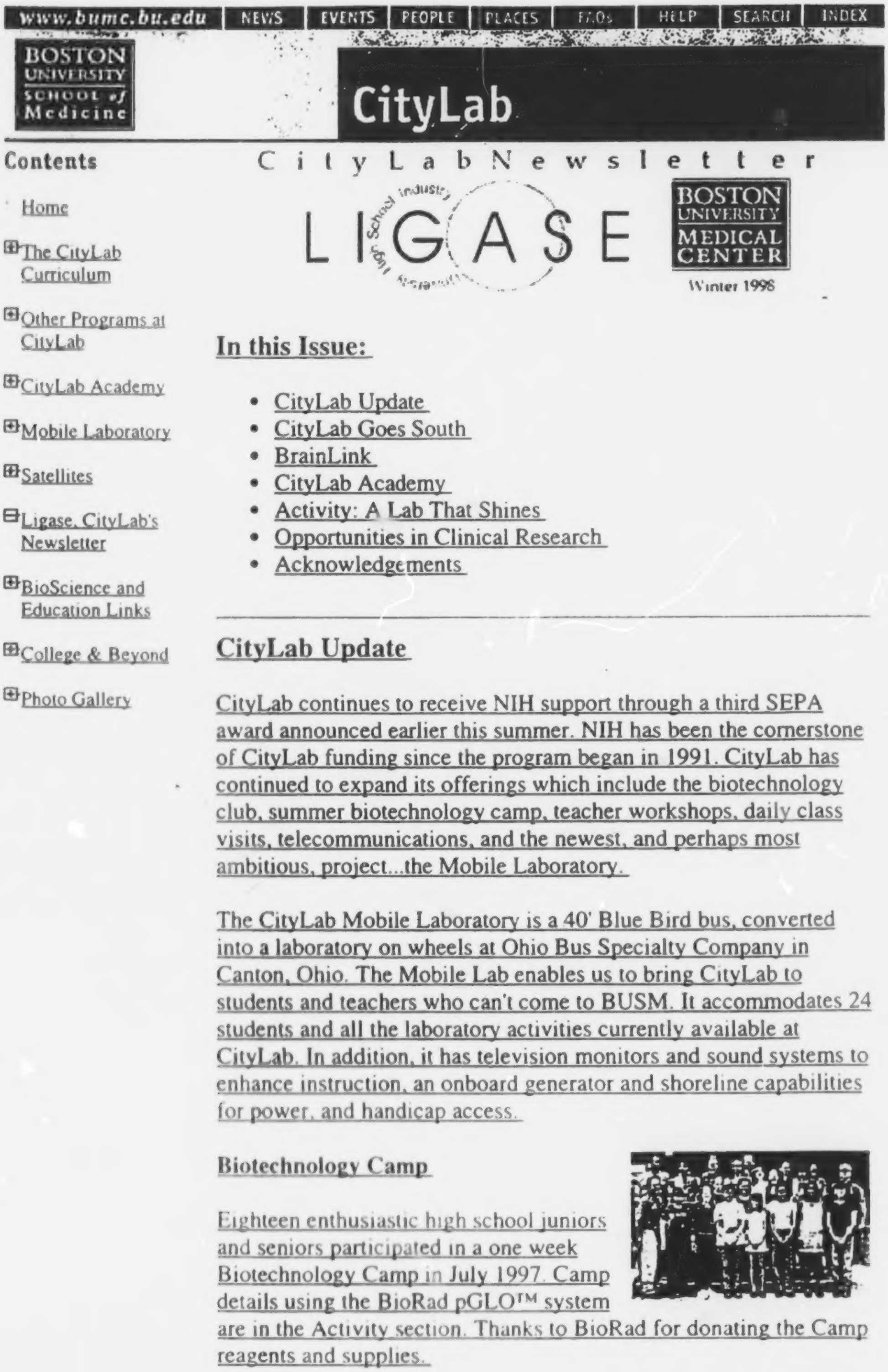
Minority High School Student Research Apprentice Program is designed for juniors and seniors who wish to work with Boston University School of Medicine faculty and perform biomedical research during seven weeks of the summer.

CityLab Academy is a nine-month, full-time education and job skills training program that focuses on biomedicine. This program is designed for students 18 years or older who possess a high school diploma or equivalent. The curriculum includes job readiness and college preparatory skills. Graduates receive 12 credits from Boston University.

The Program in Biomedical Laboratory and Clinical Sciences (BLCS) offers associate and bachelor of science degrees as well as four 16-credit certificate programs of study in biotechnology, biomedical laboratory support, biomedical laboratory sciences, clinical research associate, and clinical laboratory sciences. All of these program options are designed to meet the needs of college graduates seeking additional skills or career changes. Courses are offered in the evening to accommodate people who work during the day. The Certificate in Biotechnology program may be completed in one year, and is designed for students who possess a minimum of two years of college study with a concentration in the sciences, or strong work experience in science.

The associate and bachelor of science degrees combine general undergraduate studies with specialized training in biomedical laboratory and health sciences. These programs also require an internship or a clinical rotation to ensure students receive hands-on technical experience. The associate degree prepares students for positions such as laboratory

Exhibit 3P: CityLab Newsletter



In this Issue:

- CityLab Update
- CityLab Goes South
- BrainLink
- CityLab Academy
- Activity: A Lab That Shines
- Opportunities in Clinical Research
- Acknowledgements

CityLab Update

CityLab continues to receive NIH support through a third SEPA award announced earlier this summer. NIH has been the cornerstone of CityLab funding since the program began in 1991. CityLab has continued to expand its offerings which include the biotechnology club, summer biotechnology camp, teacher workshops, daily class visits, telecommunications, and the newest, and perhaps most ambitious, project...the Mobile Laboratory.

The CityLab Mobile Laboratory is a 40' Blue Bird bus, converted into a laboratory on wheels at Ohio Bus Specialty Company in Canton, Ohio. The Mobile Lab enables us to bring CityLab to students and teachers who can't come to BUSM. It accommodates 24 students and all the laboratory activities currently available at CityLab. In addition, it has television monitors and sound systems to enhance instruction, an onboard generator and shoreline capabilities for power, and handicap access.

Biotechnology Camp

Eighteen enthusiastic high school juniors and seniors participated in a one week Biotechnology Camp in July 1997. Camp details using the BioRad pGLO™ system are in the Activity section. Thanks to BioRad for donating the Camp reagents and supplies.

CASE STUDY CONT.'D

technician, research technician, and medical laboratory technician. The bachelor of science degree provides training for more advanced positions in research and hospital laboratory environments. A masters degree in medical science with a concentration in clinical research is being developed for students who already possess a bachelor's degree in science.

The response to CityLab has been overwhelming. Schools schedule visits to CityLab a year in advance. From September 1992, 16,000 students have paticipated in hands-on, discovery oriented investigations at CityLab, and 1,500 teachers have attended City Lab workshops. Approximately 32 percent of students are minority, 50 percent of participating students are female, and 33 percent represent Boston Public Schools. Over 520 students participated in after-school programs at CityLab, and the CityLab minivan (which preceded the current much larger bus) served about 1,500 students at many area schools.

More Specifically Targeted Programs

Following are a number of brief examples of how some programs, many described in earlier sections, are responding to the needs of various student populations:

Lincoln High School: in San Francisco: The Principles of Biotechnology course is designed to serve three different groups of students within the same class. For students who are less academically inclined, the course provides basic employability and technical skills that will give course graduates a competitive advantage in applying for entry-level technician jobs in the area's growing bioscience industry. They can work as media prep assistants and general laboratory assistants. In the class they serve as teaching assistants, helping the teacher prepare classroom materials.

For average students who plan to continue to four-year colleges, the instructor helps them focus on a career goal that includes at least four years of college and entry-level work experience as a research assistant at an area workplace. The instructor arranges for these students to work in after-school jobs as laboratory assistants in nearby colleges.

The students who seem to be the most gifted and are highly motivated receive as much training and information about the field and career opportunities as possible. The instructor tries to place these students in summer internships at the University of California. They are given the most challenging work to do in the class.

Advanced information about the students is available to the instructor since he or she maintains a close relationship with the school's counselors and other faculty members. The instructor also requires prospective students to answer a survey designed to ascertain their interests and commitment to the subject matter.

Some colleges run programs designed for adults with specific constraints and cannot attend traditional courses.

Madison Area Technical College: The biotechnology program is considering developing modules that will teach specific groups of skills required for particular occupations. For example, if a biotechnology company wanted to hire media prep workers, a specific module including these skills, as well as basic employability skills, will be taught. A certificate acknowledging the mastery of this module will be awarded to students who successfully complete the work.

As individuals grow in their jobs, they will be able to return to school to take additional modules, for which they will receive certificates. In this way, people who are not able to spend sustained periods of time in school (e.g., people receiving welfare benefits who must find employment quickly) will be able to build their knowledge and skill base and their certifications. Eventually some people will be able to earn degrees, which qualify them for advanced work positions or entry into higher levels of education. To accommodate these needs, the program will be required to offer several different modules repeatedly during the year, which may require additional staff resources.

University of Maryland School of Medicine (UMSOM): The Department of Medical and Research Technology offers students a part-time program option. Because many of UMSOM's students are adult learners with family responsibilities, a flexible curriculum has been developed, which allows students to take an additional year to complete their studies. This enables students time to balance their work, school, and family responsibilities.

Associate degree and certificate programs that emphasize laboratory skills often attract students who already hold more advanced degrees. These students typically possess theoretical understanding, but not the practical skills or exposure to state-of-the-art equipment that employers demand. Following are two brief examples of such programs:

California State University at Hayward: Biotechnology Certificate Program (BCP), competitive, limited enrollment *requires* applicants to hold a baccalaureate degree in biology or chemistry (including microbiology, biochemistry, genetics, cell or molecular biology, and immunology). This program, which is designed to be completed in three academic quarters, features courses such as Protein Chemistry Techniques, PCR Techniques, Cell Culture Techniques, and Genetics Laboratory. All courses have a minimum of 60 hours of hands-on training. An evening program is under consideration.

Madison Area Technical College: Bioscience employers in the Madison, Wisconsin, area who were interested in providing their incumbent employees' with training sought a program to upgrade employees' laboratory skills. The employers were not satisfied with the traditional programs offered in the context of academic institutions. The college responded to the needs; it designed a custom training program on a contract basis, to be delivered at the employer's site.

Creative Ways to Recruit Students

The following are examples of creative methods used by various program directors to recruit students to their programs, including those who would not usually consider applying:

San Diego City College/Center for Applied Competitive Technologies (CACT): The program coordinator of the capstone course recruits students a year in advance to provide counseling opportunities for adjustment in prerequisite course planning. Students are recruited from presentations given by the program coordinator in prerequisite courses, ads in semester schedule of classes, publicity from local newspapers, referrals from university faculty, and word of mouth in the biotechnology community. Interested students are encouraged to observe the course in action and view videotaped impressions of course graduates. Prospective students are asked to complete a questionnaire detailing their academic and vocational background and aspirations. Students are questioned about the amount of time they can devote to the course and their willingness to give and respond to weekly evaluation. Students must also obtain permission from the coordinator to enroll. A pre-semester party with staged activities has been held each year to introduce students to one another and to the industry instructors.

University of Maryland School of Medicine: Juniors and seniors in the Department of Medical and Research Technology participate in high school and community college open-house events where they give brief hands-on presentations about techniques used in biotechnology laboratories. In addition to showcasing the current students' academic, technical, and presentation skills, prospective students are given the opportunity to see demonstrations of actual techniques and the equipment used. These presentations have been used effectively to attract students from two-year biotechnology programs. During recruitment efforts, the academic coordinator of the University of Maryland's Department of Medical and Research Technology program informs prospective students about available financial aid. The University of Maryland Chancellor's Office offers $1,000 scholarships to eligible students who enter the two-year program.

Baltimore City Community College: The college conducts an open house for high school biology and chemistry teachers and counselors to discuss their program(s) and encourage them to bring their students for an orientation to college campuses so students can see what college is like. The life sciences program at the college offers students an orientation to the college campus and introduction to available services and a course that teaches them how to take notes and exams and succeed in school. The school reports an increase in college applications from these high schools.

Berkeley Biotechnology Education, Inc.: This company recruits prospective students from Berkeley and Fremont High Schools' ninth-and tenth-grade science classes into its biotechnology program. These students meet with upper-level students and program graduates who are of similar age and backgrounds, but who have experience working in the biotechnology industry. Using successful young students and program graduates to help recruit prospective students is a powerful technique. BBEI also shows a video that profiles the program, following students and their families from the beginning of the program through graduation.

Abraham Lincoln High School: Juniors and seniors who wish to enroll in the Principles of Biotechnology program must complete a student survey and meet academic prerequisites. The student survey is used to ascertain academic interest, accomplishments, and goals as well as commitment. (*See exhibit 3Q.*) The course has several prerequisites, including two years of high school science, an algebra assessment, and permission of the instructor.

MiraCosta College: Many educational institutions use technology to attract and inform prospective students about their programs. MiraCosta College publishes a regular newsletter with information about the biotechnology program offered at the college and includes regular features on graduate success stories. These profiles of successful graduates motivate prospective students to investigate and enroll in the program and inspire incumbent students. Information about their biotechnology-related curriculum, workshops, resources, and career opportunities is available on their web homepage. (*See appendix B.*)

Ways to Recruit Students from Underrepresented Groups

Recruiting students who typically may not consider bioscience education programs, or emerging career opportunities in this field, may require special outreach efforts. Following

Exhibit 3Q: Biotechnology Survey

Biotechnology is a relatively new branch of science. Biotechnology uses engineering techniques on biological organisms to create new health care products and to try and solve some difficult environmental problems. The biotechnology industry is centered in the bay area, where over 70% of US companies are located. Abraham Lincoln High School is considering offering students a chance to prepare for this industry by implementing a two year course in biotechnology. Students would be required to commit to a demanding program involving learning to use sophisticated equipment and laboratory techniques used in the biotechnology industry. The course would probably involve a double school period, and an internship *off campus* in industry in the afternoons of your senior year. It will require a big commitment from students. In return, it offers a good career goal to a self motivated few. There are over 420 biotechnology companies in the bay area. Starting salaries are good. Very good.

The purpose of this survey is to see if there is any student interest in ALHS developing this opportunity. Please answer the questions honestly. We don't want to waste our efforts if students aren't interested. This is an anonymous survey.

1. Would you be interested in participating in a biotechnology tech prep program at ALHS? (circle one choice)

Very Interested   Possibly Interested   Not Interested

2. Would you be willing to commit to an off campus internship during the second semester of your senior year? (circle one)

Willing to commit   Maybe   Not willing to commit

3. Were you aware that the biotechnology industry is based in the bay area? (circle one)

Yes   I heard something about it   I never heard that before

4. What subjects in school especially interest you?

(exhibit 3Q cont.)

5. Are you planning on attending college? Yes Maybe No

6. Do you participate in any after school activities? What are they?

7. Do you feel you have a career goal or direction in life? What is it?

8. In general, do you enjoy science? Why or why not?

9. What science courses have you taken at ALHS?

Personal Information Please answer the questions below so we can assess which students might be interested in a biotechnology program.

Grade________________ Male or Female? ___________

Current GPA _________ Science GPA _________

Do you use MUNI (public transportation)? _______________

Are either of your parents or guardians college graduates? __________

Was high school biology a difficult subject for you? ________

Please use the space below for any thoughts, comments or suggestions on how to make a demanding course more accessible or attractive to students. Thank you for your input, it is very much appreciated.

are two examples of ways in which programs can recruit more women into science programs.

Madison Area Technical College and the University of Wisconsin: These two institutions jointly sponsor workshops to promote career opportunities for women in technical areas. The workshops, which are targeted to middle school girls and returning adults, feature female speakers who discuss their nontraditional career paths.

MiraCosta College: Links: a program at the college which is funded by the state, focusing on encouraging young women and girls to pursue careers in math, the sciences, and technology. The program does this by offering workshops, field trips, guest speakers, and showing college facilities. They also offer introductory lab-based biotechnology workshops that are open to all interested students and members of the community.

To be effective, recruitment efforts must reach your target audience and explain the opportunities and benefits of the program in terms that will interest them. For students, parents, and adults, the main motivation for enrolling in education-to-employment programs is the promise of employment and career opportunities. Use recruitment strategies, such as targeted advertising, and be sure to offer evidence of program graduates' success.

Industry partners can contribute to recruitment efforts. For example, companies can lend their marketing expertise to help advertise programs. They can also participate in public discussions to provide parents, teachers, career counselors, job placement specialists, and prospective students with knowledge about the industry and the potential career opportunities within it.

5

How Can Work-Based Learning Strengthen a Program, and How Can It Be Developed and Managed?

Work-based learning refers to the hands-on learning done by students outside the classroom, usually in a work setting but sometimes in a community-based setting. Students learn by observing or performing work related to the career area they are studying in school.

How Skill Standards Can Help

Skill standards define the tasks, skills, academic knowledge, and behaviors inherent in the work the students will be observing or performing in the workplace or community-based setting. The standards enable the educators and the work-based supervisors to use a common language to define what a student will be learning during his/her time outside the classroom. Specific knowledge, technical skills, and behaviors that can be learned in a work or community setting can be identified, and a work-based curriculum can be planned. The skill standards can also be used as performance criteria for the work-or community-based supervisor to assess the degree to which each student masters the knowledge, skills, and behaviors stipulated in the plan.

What Is Work-Based Learning?

There are several basic types of work- or community-based learning:

Mentoring - a process by which an employee forms a personal relationship with a student for the purpose of helping the young person learn about and practice work skills. It is used most often with middle grade or younger high school students to assist them with career exploration, encourage them in their school work, and help them develop employability skills, such as responsibility, punctuality, proper dress, and workplace behaviors.

Shadowing - a process in which a student follows a worker throughout one or more days to observe his or her activities and interactions in the work context over a period of time. It is used most often with middle grade or younger high school students to familiarize them with the variety and flow of work an employee experiences. When used with older students, it is intended to give them an idea of what a person in a particular occupation and work setting does and experiences.

Internship - a short-term, intensive learning experience with formal, individualized educational objectives, which are closely tied to those of school-based learning. Internships usually occur near the end of one's school-based learning experience. It is a way for students to gain practical work experience, and usually focuses on one or more areas of specialization. Often interns are paid a nominal wage, or given course credit.

Cooperative (co-op) work - alternates periods of school-based learning with periods of paid work. Typically the student attends classes for part of the day and is released for work part of the day, or alternates time in school and in the workplace. Co-op experiences are usually for college students, who have mastered enough knowledge and skills to be productive in the workplace. The co-op job should be productive and directly related to the school-based learning.

Besides enabling students to hone academic and technical knowledge and skills, work-based learning can teach behavior skills such as teamwork, self-management, problem analysis and problem solving, decision making, negotiation, and project-based work. It can also help develop behaviors such as self-reliance, self-esteem, ability to work well with others, resourcefulness, organization, and integrity.

How Can Work-Based Learning Experiences Be Developed and Managed in a Program?

Cultivating the relationships necessary to obtain, coordinate, and maintain work-based learning experiences takes a great deal of time and resources. Program coordinators often find that employers asked to provide work-based learning experiences are initially reluctant. Experienced program developers suggest these tips:

- Begin by looking for organizations that are committed to the community and that want to work with a school or schools;
- Identify the individual(s) with the necessary clout to institutionalize the arrangement;
- Request a one-to-one meeting and present the idea in person;
- Educate employers about your students' potentials, abilities, and the value of their technical skills.

Employers must support the concept of work-based learning by allowing their employees time to mentor and/or supervise students and to meet with school staff to plan and implement programs. Employers must be willing to allow students to spend time in their workplaces, often rotating among several departments and working with a number of people in that workplace. Employees who supervise entry-level workers or students need the support and recognition of management.

Work site supervisors are responsible for all the student learning that occurs in the workplace. This includes ensuring that students learn about the organization's goals and products, as well as the particular departments students works in. It also includes ensuring students learn the proper work behaviors and skills that have been designated as the work-based component of the learning program. The work site supervisor or mentor must be willing and able to supervise or mentor students, which requires some training in how to work with school-age people. The supervisor or mentor also instructs students in the necessary skills, and critiques and assesses the students' performance and behavior.

Parents should be fully aware of the goals, structure, and expectations of the school and work-based program, and play an active role in encouraging and supporting the participation of their children in the program.

Coordination between the school-based and work-based learning is essential to maintain a smooth continuum of learning and ensure that all of the planned curriculum is covered. This coordination requires teachers and work place supervisors to interact regularly, first to plan which aspects of the learning can best happen in school or at a work site, and then to maintain coordinated learning and track each of the students. Work-based supervisors must be able to spend time developing and maintaining the learning experience, in addition to supervising their assigned students. They also need to prepare their own workers for interacting with the visiting students in a positive way.

For internships and co-op work, a set of forms should be developed that stipulate the precise roles, work requirements, and expected outcomes for parties—students, work-based supervisors, teachers, and parents. A contract should be developed and signed by all parties. In cases where student internships are primarily training experiences, students may have to accept unpaid internships. However, if the company is making a profit on the work students are producing, programs and employers need to decide whether and how to pay students.

All these efforts are necessary to ensure that a student's work-based experience is a real and productive learning experience, related to the basic education program goals. Below are two examples of work-based learning, coordinated with school-based learning.

Berkeley Biotechnology Education, Inc. (BBEI)

The BBEI program uses extensive paid, supervised internships for high school students and co-op job experiences for community college students to reinforce the connection between what students learn in school and the skills required in laboratory-related occupations. By the time a student finishes two years of the Biotechnology Academy in high school and the one-year Career Institute at Laney College, he or she will have had at least one internship experience and one full year of part-time co-op work, while taking college courses. Students will have completed close to 1,300 lab hours during the three years in the program. (*See exhibits 3R and 3S.*)

The teachers and program coordinators have implemented many mechanisms to ensure a good match between the intern and employer goals and expectations. Students must formally apply for an internship. Only those who have attained the academic performance, technical and employability skills, and attendance requirements are eligible for the paid internship positions. Students sign a formal contract, agreeing to maintain a C or better grade in their science classes, and to comply with employee rules and responsibilities (dress policy, safety regulations, arriving at the work site on-time, confidentiality, etc.). Together, student interns, their site supervisors, and the program coordinator or teacher formulate the formal work-based learning objectives and expectations. They answer the following questions: What tasks will the student complete? How will the student accomplish it? How will it be measured, evaluated, or rated, and who will do this? How much time will the student spend on the task, and when will he or she complete it?

A typical BBEI work-based learning objective:

Department: Science Program: Biotechnology

Internship: Laboratory Assistant

Task: "I will operate an instrument that measures tissue samples and will use a bar code reading device to record data about each sample and transfer data from the reading instrument to a computer database. I will spend 75 hours on this task by the end of the semester and my supervisor will verify this."

Students review the job functions and tasks of a bioscience technical specialist, and the work-based scenarios from the national bioscience industry skill standards to gain an understanding of the essential elements of a student's work experience assignment.

BBEI provides interns and their supervisors with training binders and extensive guidance and support. Each intern attends an orientation given by BBEI staff, and typically receives a comprehensive orientation from his or her site supervisor that covers organizational and departmental information as well as a safety review. Students receive a copy of the Summer Intern Information and Consent Form. This contains general information about internships, an acceptance letter, a list of their responsibilities, an agreement for them and their parents to sign, information about work rules in general, and specific information about

Exhibit 3R: Purpose and Goals of Internship Program

PURPOSE

The purpose of the hands-on work experience is to link classroom learning with the knowledge, skills and behaviors required for success on the job. The internship is designed to provide students with an exposure to the world of work in science-related industries. The program also works to establish professional relationships between students and science workers. Supervisors help students learn hands-on skills, develop appropriate work behavior and serve as role models/mentors to foster personal and professional development.

GOALS

Students learn hands-on skills relevant to an assigned work area by:

- Learning specific assays
- Preparing solutions, diluting solutions
- Applying math, chemistry and biology skills
- Practicing lab safety
- Monitoring manufacturing processes and procedures
- Cleaning tools and equipment
- Using computers
- Converting units of measure

Students gain exposure to the world of work in a scientific setting by:

- Observing the advantages and disadvantages of working in different environments
- Conducting research, testing, and documentation
- Examining scientific career options

Students learn to work as team members in the job setting by:

- Practicing professional behavior in work interactions
- Observing diplomacy among fellow workers
- Completing work responsibilities in a timely manner
- Practicing effective work behaviors: integrity, ambition, initiative, honesty, teamwork, punctuality, thoroughness, follow through

Exhibit 3S: Typical Intern Assignments (Summer 1997)

- Biochemistry Laboratory Assistant
- Cell Biology Laboratory Assistant
- Cholesterol Research, Research Assistant
- Clinical Lab & Microbiology Lab Asst.
- Document Management System Scheduler
- Environmental Assistant
- Exercise Physician Intern
- Expression Tech. Lab Assistant
- Fermentation Assistant
- Fermentation Assistant Biotechnician
- Glassware Operator/Media Preparation
- Hospital Lab Assistant
- Immunochemistry Research Assistant
- Laboratory Assistant
- Life Sciences Research Assistant
- IS User Support Technician
- Media Worker
- Multi-Lab/Administrative Support Asst.
- Office Clerk
- Plant and Macrobial Biology Lab/Field Asst.
- Plant Biology Assistant
- Preclinical Molecular Immunology Lab Assistant
- Process Control Systems Technician
- Program Assistant
- Protein Purification Assistant Biotechnician
- Public Health Lab Technician
- Quality Assurance, Bioanalyst III
- Quality Assurance, Chemistry Assistant
- QA, Environ. Monitoring, Bioanalyst III
- QA, Microbiology Bioanalyst III
- Quality Control Laboratory Technican
- Quality Department Laboratory Assistant
- Research Apprentice
- Research Assistant
- rFVIII Documentation Coordinator
- rFVIII Fermentation Clerk
- Sterilizer Operator/Equipment Washer
- Stratospheric Protection Assistant
- Student Research Fellow
- Technical Laboratory Assistant
- Technical Training Coordinator Assistant

their employer and their job, and information about future employment possibilities. The students sign an Intern Responsibility Statement, a statement of confidentiality, and a release for photographs and videos. Each student intern also agrees to submit to drug testing, giving a blood sample, and to abide by safety and conduct rules. The student's work-based learning responsibilities and expectations are communicated to the students and parents, and parents must sign a consent form.

BBEI's education director and workforce coordinator provide employers and supervisors with many support services as well, to facilitate their role in the work-based learning component. BBEI provides each supervisor with an Internship Start-Up Kit which contains all the necessary information and forms they need (e.g., job description of intern supervisor, description of internship job title, work schedule, duties and responsibilities, skills to be taught, student performance evaluation form, directions for writing weekly report, and training suggestions). Each work site supervisor also receives a handbook with tips and examples written by other supervisors who share how they have broken down a skill step-by-step to teach an intern. The supervisor or mentor attends an orientation and ongoing planning meetings with the program coordinator.

The BBEI education director and workforce coordinator monitor the quality of internships several ways. Regular communication is maintained between the intern, the site supervisor, and the teacher. During the first month of the internship, they phone both the intern and the supervisor to check how things are going. Faxes and e-mail are also used to keep in touch. The BBEI program coordinator frequently transports students in a personal vehicle. This commuting time allows students to debrief their interviews. BBEI also sets aside money in its budget to pay the transportation costs for students with lengthy commutes and without financial means.

Students' files help them maintain coordination between school and work-based learning. These files include assessments, letters received from employers, and the school's work attendance information. Each site supervisor provides extensive verbal and written assessment of the intern's performance, including an evaluation of the quality of the student's work, their level of cooperation and attitude toward work, success in meeting the internship objectives, and feedback for improvements. (*See exhibit 3T.*) Student interns also provide verbal and written self-assessment, including keeping a journal, a written self-evaluation of their workplace, and feedback about their experience during an exit interview with the program coordinator. (*See exhibit 3U.*) Both the interns and their supervisors complete a brief evaluation form two or three times during the internship. Instructors also visit the workplace to see the interns in their work environment.

Teams of community college instructors and high school teachers visit industry sites where students have internships or co-op placements to obtain feedback from students and supervisors. During these visits, teachers learn what it takes to place students on the job and what the expectations are for success in the work-based learning component.

Exhibit 3T: Summer Intern Performance Evaluation

Intern ________________________________ Supervisor ______________________________

Company ____

Two Week Rating _____
To be completed by July 19, 1996

Five Week Rating _____
To be completed by August 9, 1996

Eight Week Rating _____
To be completed by August 30, 1996

Be as complete and specific as possible. Place a check mark after each item in the column that best describes the individual's performance. Explain any items on which you mark "needs improvement".

O =	Outstanding	Performance is truly superior on a consistent and sustained basis.
C =	Commendable	Performance frequently exceeds normal job requirements and expectations.
G =	Good	Performance meets position requirements and expectations.
NI =	Needs Improvement	Performance does not meet all job standards, objectives, nor expectations.
NA =	Not Applicable	

	O	C	G	NI	NA	Comments
Attendance/Promptness						
Quality of Work						
Amount of Work						
Safety						
Cooperation with Others/Co-workers and Supervisors						
Organization Skills/Accurate Record Keeping						
Compliance with Good Laboratory/ Manufacturing Practices						
Attitude toward Work						
Other						
Overall						

(continued exhibit 3T)

Additional Comments: ______________________________

____

____

If applicable, describe the plan the intern will follow to improve current level of performance: ______________

____

____

Supervisor Signature: ______________________________ Date: ______________

Intern Comments: (Describe a work performance goal you have set for yourself to work toward over the next three months.) ______________________________

____

____

____

____

Intern Signature: ______________________________ Date: ______________

Exhibit 3U: Intern Evaluation of Experience

Throughout my experience at Chiron I have learned a lot of important values and techniques that apply to working both inside and outside of the laboratory. I learned most of my techniques from my supervisor, Jay, but I also learned many values on my own. Among all the techniques I learned, such as running protein and DNA gels, Qiagen Maxi and Mini-preps, and DNA restriction digests, the most important duty was to simply focus on what is being done. This proved to be harder than it seemed.

I have made a mistake in every experiment I have done. I have never made the same mistake twice, and although I learned from them, Jay still saw it necessary to remind me of them every Friday and tell me I need to focus. Coffee helped a little bit with this but since I can't drink coffee twenty four hours a day I needed to learn to focus. This was the hardest and most valuable skill I took from this internship. Although I haven't mastered the art of focusing yet I learned how important it really was in the real world.

In school it is necessary to focus but not to the degree of my job at Chiron. If you zone out while listening to a lecture you can usually catch on or ask the person next to you, but in the lab you can't turn to the person next to you and ask them what step in the protocol you were in, because there usually isn't someone next to you. There were a few times when while doing a Qiagen prep I forgot how many times I added a solution. Luckily it was a salt wash and an extra one can't hurt. Had I done that in the middle of a restriction digest, and forgotten if I had added the enzyme I would have been in trouble. In a restriction digest the quantities are so small and the DNA and enzyme are so fragile that if I don't focus than I can ruin the experiment and the DNA.

A very important thing to do is to check up on yourself every once in a while. By this I mean to just take a minute to ask yourself "What am I doing right now, why am I doing it, and what was I doing previously that needs attending to." Towards the end of my internship I started doing this. This not only kept me from making silly mistakes, but it also helped me to look for things that could be going wrong in the experiment like contamination. Before I started doing this I would do things like put yeast, which grows at 30 degrees, in the 37 degree bacteria shaker. When I started asking myself what it was that I was growing I stopped making silly mistakes.

I learned that it is also important to focus on safety practices. Sometimes a certain chemical can be very dangerous, like ethidium bromide which I use frequently to stain DNA gels. This chemical can cause cancer so it is important to keep a clear head so that it isn't spilled and so that any thing that comes into contact with it is sterilized properly or thrown away. It is very important that gloves are worn and that those gloves are thrown away after usage.

Being able to focus is such an important skill, not only in the lab but in the classroom and any other job that I may have. I will take this skill with me and it will improve as time goes on.

Students who have graduated from a program and are currently working sometimes can help other students find work. BBEI promotes a sense of community among students by creating many opportunities for them to interact during the school day. They come to see one another as a network of colleagues.

When internships were introduced at Bayer, some union members and representatives thought interns would compete for the same work as union members. To optimize their potential as partners, union representatives became involved in every step of planning the program; the union steward sits on BBEI's advisory committee. It was important for union members to recognize that the internships are primarily training vehicles, and that interns are paid less than regular workers, and that the program has been designed to limit the time period for work experience training. Extended education and training opportunities are also offered to current union workers.

Project SMART

An 11th-grade work-based learning program component, including comprehensive guidelines for the work-based learning experience

As part of the four-year, high school level School for Manufacturing and Related Technologies (Project SMART) in Cleveland, Education Development Center, Inc., Youth Opportunities Unlimited, Inc. (Y.O.U.), and their Cleveland partners developed an 11th-grade Comprehensive Job Shadowing component, accompanied by *Work-Based Learning in the Manufacturing Firm: A Guide for Intensive Exploration within an Industry*. The guidebook is for students, teachers, and work-based supervisors, to ensure that students receive a comprehensive, skill standards-based learning experience in their work-based placement.

Every student in the Academy must participate in a nine-day unpaid internship in a local manufacturing workplace. (The experience is referred to as a "job shadowing" experience, although it is much more extensive and intensive than typical job shadowing.) A contract is signed by the company liaison from each workplace hosting interns, which stipulates what the supervisor(s) will provide to students in the program, and how they will interact with the school. (*See exhibit 3V.*) During the internship, students spend time in each of five departments in the workplace, to gain a comprehensive understanding of the entire organization and its functions. The five departments are Design/Engineering, the Shop Floor, Quality Control, Shipping and Receiving, and Finance Management. In each department, students are mentored by department supervisors. The experience is designed to orient students to the manufacturing firm, its organization and work processes, and potential career opportunities. It prepares students for half or full-year paid internships during their senior year.

Exhibit 3V: Work-Based Learning Program Company Liason Contract

As liaison for an organization participating in the Work-Based Learning Program, I understand and agree to the following conditions:

1. A student(s) will report to our facility two days each week for the duration of the nine-week program.
2. During this time I will provide the student(s) with a learning experience that addresses the goals and objectives set forth in the Department Learning Guides provided by the program coordinator.
3. I will serve as liaison to the school before, during, and after this learning experience.
4. I will maintain adequate supervision for the student(s).
5. I will serve as the overseer of the program within my company.
6. I will ensure that each student receives a company orientation on safety procedures and regulations.
7. I will work with the program coordinator and department supervisors to design a learning experience for each department.
8. I will ensure that all department supervisors involved have read and signed the Department Supervisors Contract.
9. I will ensure company participation in the interviewing and selection process of candidates.
10. I will participate in, and encourage supervisors to participate in, the orientation program provided by the program coordinator.
11. I will oversee the completion of all Department Learning Guide assessments for each student and participate in post-program assessments.
12. I will meet with the program coordinator at least twice during the nine-week period.
13. I will arrange for monitoring of the student worksite experience by school staff.
14. I will monitor the attendance and sign-in form of each student and ensure that the student is released from the worksite no later than 2:30 P.M. each day. I will call the program coordinator if the student does not report to the worksite as scheduled or if the student leaves the site early.

– continued –

(continued exhibit 3V)

I understand that the Work-Based Learning Program is designed to give each student an orientation to the manufacturing process and several areas supporting that operation. The training should not focus on any one machine.

STUDENTS ARE NOT TO OPERATE ANY POWER-DRIVEN MACHINERY OR EQUIPMENT.

I am familiar with the Minor Labor Laws and agree that our organization shall abide by the rules and regulations set forth in those laws.

Although I have received confirmation that this experience is a program of the

______________________________ , meaning that liability for the student rests
name of school
with the school system, I acknowledge that my company does carry "General Liability Coverage" that protects all staff, as well as visitors to our facilities.

I also understand that I have the authority to dismiss any student immediately for unacceptable behavior or refusal to abide by the safety rules and regulations set forth by the company.

Name: ______________________________

Signature: ________________________ Date: __________

Title: ______________________________

Company: ______________________________

CASE STUDY CONT'D

The Work-Based Learning Guide first describes the roles of all participants in the component: students, parents and guardians, program coordinator, teachers, company liaisons, and department supervisors. It then provides guidelines for implementing the various steps of the component:

- Planning;
- Preparation and setup (teacher development, student recruitment);
- Orientation of company personnel (student supervisors), students, parents;
- Debriefing (preparation), including review of school-based learning to date, review of industry skill standards that form the basis of the Academy curriculum, students' career interests;
- Matching students with companies, including gathering information on students and companies, and interaction among students, employers, parents;
- Work-based learning guidelines for the student supervisors in each department.

The Work-Based Learning Guide has a different section for each of the five manufacturing departments. All of the sections have the same content: an overview; the specific skills and knowledge students need for work in that department; directions on hosting students; suggestions for specific work-based learning activities; sample problems for students to solve in workplace settings; and assessment materials. In addition, each section includes a set of forms for recruiting, placing, supervising, and assessing students. The required knowledge, skills, and behaviors are derived from a DACUM job analysis conducted by workers and supervisors from manufacturing firms in the Cleveland area.

Following is an overview of a sample department section from the guidebook:

Design/Engineering Department

Introduction — explains how many days students spend in each department and provides a rotation schedule.

Goals — encourage students to become self-reliant learners, thinkers, problem solvers, and skilled workers through development of basic technical skills needed for the department, and to visualize how the department fits into the overall organization of the company. Students also are responsible for answering the research question, How can this company be seen as a system, and how can each department be seen as a subsystem within the company?

Procedures for Hosting a Student — outline procedures and methods for encouraging and fostering students' learning experience, as well as guidelines for supervising and observing students. Questions for end-of-day discussions are also outlined. Sample questions include:

- Tell me about this department; what do people who work here do?
- What skills do people need to work in this department?
- What answers did you find to your research question?
- What did you like most/least about working here?
- What areas in the company are you interested in learning more about?

Manufacturing-Related Duties and Tasks — taken from the local manufacturing industry skill standards DACUM job analysis chart. Sample duties and tasks include:

DUTY D: Reading/Drawing/Interpreting Blueprints, Sketches, and Assembly

Task D-1: Read/interpret the title block and tolerance block

Task D-2: Read interpret bill of materials

Task D-3: Read/interpret notes, features, dissemination, and types of lines on blueprint

DUTY E: Designing/Carrying Out the Manufacturing Process

Task E-2: Write a good manufacturing process

Task E-4: Produce set-up sheets.

Suggested Work Activities — highlight activities thought appropriate for the student's learning experience. Sample activities include the following:

- Check the bill of materials and see if the materials are in stock;
- Spot-check tolerances using appropriate measurement(s);
- Assist in assembling models/prototypes;
- Monitor beta test equipment, including the number of runs between failures.

Sample Work Scenarios — prepare students for workplace skills such as problem solving and decision making that require cognitive skills as well as technical skills. Project SMART developed a set of scenarios that capture the realities of work in a manufacturing firm. The scenarios require students to draw upon a number of industry-related tasks and knowledge they have mastered. For example:

Scenario 3

Produce a sketch and a manufacturing plan for 25 aluminum plates measuring 1.00x2.50x3.50. Three holes measuring .375 in diameter are to be drilled through the 2.50 and 3.50 side equidistant on a 1.50 bolt circle, which is centered on the side. One hole must intersect the diagonal. Work is to be performed on a computer-numeric-controlled (CNC) vertical milling machine.

CASE STUDY CONT.'D

Scenario 7

You checked with the manufacturing personnel who typically apply the epoxy to the endoscopes (*see Scenario 6*) and discovered that 5-minute epoxy was used in place of high-temperature epoxy. The method sheet you found reflected a change from 5-minute to high-temperature epoxy. However, you find that workers are currently applying 5-minute epoxy to the endoscopes. Once the cause is identified, what action do you take?

Self-Directed Learning — two activities provide opportunities for students to practice self-directed learning, organize their work-based learning, and answer research questions

Assessment — a form is provided to every supervisor for each student that cycles through his or her department. Supervisors complete these forms, which assess student performance and learning experiences. (*See exhibit 3W.*)

Although the content of this guidebook focuses on manufacturing, the structure is generic, and can be adapted for use by practitioners who are developing and implementing work-based learning in any industry.

Brief Examples of Creative Work-Based Learning Development

Here are some brief examples of ways that education program directors, intermediary organizations, and others have created work-based learning opportunities, and have dealt with some related issues.

Contra Costa Community College: The program developer found that private sector employers were more receptive to creating internships if she targeted her request to areas where she knew they needed assistance. She would suggest the school provide a certain number of interns the first year and a certain number the second year. She maximized internship opportunities. She arranged with a number of employers to each provide one internship position per year, with the stipulation that it could be shared among several rotating students.

Northern California Biotechnology Center: Based at City College of San Francisco, the center held a workshop designed to encourage employers to hire interns from the area community colleges' biotechnology education programs. This workshop, funded by federal Tech Prep money, helped education program developers understand specifically what employers were looking for in new-hires and the benefits of a partnership with their school. It also gave program coordinators a chance to familiarize employers with the availability, skills, and abilities of their students available to serve as interns.

Southern High School: Located in Baltimore, Maryland, the program coordinator of the Bioscience Academy was determined to create work-based learning opportunities for ninth-and tenth-grade students. Since there are many obstacles to hiring younger students, the program created its own solution—a small school-based enterprise. The program coordinator arranged for the school to remain open during the summer so that students could collect samples of biosurfactant, which were then sold to area scientists.

Exhibit 3W: Work-Based Learning Assessment Form

VIII. Assessment

Each department supervisor should fill out an assessment form for each student who cycles through the department.

Work-Based Learning Assessment Form

Student Name ______________________ **Date** ______________

Department ______________________ **Supervisor** ______________

Please answer the questions below:

Skills

Did the student	poor	fair	average	very good	excellent
Maintain personal safety?	☐	☐	☐	☐	☐
Maintain clean and safe work stations?	☐	☐	☐	☐	☐
Maintain tools and equipment?	☐	☐	☐	☐	☐
Demonstrate basic shop math skills?	☐	☐	☐	☐	☐
Interpret different measuring systems?	☐	☐	☐	☐	☐
Interpret blueprints?	☐	☐	☐	☐	☐

Employability

Did the student	poor	fair	average	very good	excellent
Apply decision-making techniques in the workplace?	☐	☐	☐	☐	☐
Apply problem-solving techniques in the workplace?	☐	☐	☐	☐	☐
Have good attendance and punctuality?	☐	☐	☐	☐	☐
Display appropriate attitude and hygiene?	☐	☐	☐	☐	☐
Display awareness of company organizational structure?	☐	☐	☐	☐	☐
Maintain positive interactions with others?	☐	☐	☐	☐	☐
Show characteristics needed for advancement?	☐	☐	☐	☐	☐
Display comfort with a variety of technologies?	☐	☐	☐	☐	☐
Demonstrate effective teamwork skills?	☐	☐	☐	☐	☐
Use effective communication skills?	☐	☐	☐	☐	☐
Display an understanding of the role the company plays in the local economy?	☐	☐	☐	☐	☐

These assessment criteria are based on Ohio's Manufacturing Technician Competencies. You may want to replace or add to this list so that it more closely matches your own local or state requirements.

(continued exhibit 3W)

Please indicate the student's experience with each task while he or she was in your department.	no exposure/ not applicable	exposed to the task	practiced the task
Use listening skills.	☐	☐	☐
Meet deadlines.	☐	☐	☐
Develop a business plan.	☐	☐	☐
Control inventory.	☐	☐	☐
Ship and receive goods.	☐	☐	☐
Enter/receive information on a computer.	☐	☐	☐
Complete forms.	☐	☐	☐
Develop or interpret flowcharts.	☐	☐	☐
Program CNC machines.	☐	☐	☐
Read and interpret notes, features, and dimensions on a blueprint.	☐	☐	☐
Employ melt drawing and/or CAD.	☐	☐	☐
Apply quality principles.	☐	☐	☐
Specify sequential operations.	☐	☐	☐
Complete record-keeping procedures.	☐	☐	☐
Specify quality requirements for component parts.	☐	☐	☐
Determine causes for quality using problems, categories of people, machines, etc.	☐	☐	☐
Inspect parts and processes according to print specifications.	☐	☐	☐
Design manufacturing fixtures, tooling, or gauging.	☐	☐	☐
Use control charts.	☐	☐	☐
Use quality-measuring devices.	☐	☐	☐
Interpret control charts.	☐	☐	☐
Access computer information.	☐	☐	☐
Keep records.	☐	☐	☐
Write technical and nontechnical reports.	☐	☐	☐
Give oral reports.	☐	☐	☐
Perform basic computer operations.	☐	☐	☐
Produce set-up sheets.	☐	☐	☐
Apply orthographic projection to visualize different views.	☐	☐	☐
Use CAD in any way.	☐	☐	☐
Explain or justify cost variations.	☐	☐	☐
Identify and use computer controls.	☐	☐	☐
Complete variable X-R chart.	☐	☐	☐
Read and document the manufacturing process.	☐	☐	☐
Make recommendations for rejection or acceptance based on quality standards.	☐	☐	☐
Complete inspection procedures and reports.	☐	☐	☐
Lay out materials according to print specifications and principles of geometric tolerances.	☐	☐	☐
Identify and select materials, tools, and accessories.	☐	☐	☐

The Columbus Center: in Baltimore, Maryland, a marine biologist wanted to provide work-based learning opportunities to students in the Bioscience Academy at Southern High School in Baltimore. Recognizing he did not have the facilities to accommodate a large number of students, he and the school program coordinator arranged internships so that two different students could participate each month throughout the academic year. Students assisted the marine biologist with his research. As a result of this experience, the scientist developed a personal interest in the success of the classroom component of the program and suggested ways for students to become partners with other scientists in biotechnology-related projects.

University of Maryland School of Medicine: Students in workplaces must often be covered by liability insurance. Sometimes the company will pay for this. Other times the school system and the company will split the cost. The university has a program which requires students to pay their own liability insurance. To ensure compliance with this policy, it is included in each student's tuition payment.

Some internships provide compensation for students and others do not. The University of Maryland School of Medicine interns are not paid, but they receive academic credit for their internships. Funding for internships may be available from a number of sources. Berkeley Biotechnology Education, Inc. raises funds from various sources to pay student interns. Berkeley city economic development funds are used to pay adult-age interns who are income-eligible. JPTA money (primarily for younger students, 14 to 15 years old) is used to subsidize internships in nonprofit organizations such as hospitals, clinics, and HMOs (it cannot be used to subsidize internships in private companies).

City College of San Francisco and North Carolina: Both institutions have used a temporary job placement agency to ensure that students receive social security, and are covered by workman's compensation or other insurance during their work-based learning experience. The college and companies negotiate the work placements and select students for them. The students are then hired by the temporary agency. The company pays the temporary agency, which, in turn, pays the students. Because the students are employed by the temporary agency, they receive benefits from that agency. Although these placements are called internships, they cannot have a formal educational structure (educational objectives are not defined and the college does not send instructors to visit the work sites). This type of placement can last up to six months.

Conclusion

Successful program development and operation is extremely time- and resource-consuming. It requires the collaboration of numerous participants, as well as individuals to direct and coordinate it. The case studies and examples provided here demonstrate some of the outstanding programs that are enabling quality education-to-employment to happen.

Creating Curriculum

Moving from skill standards to a fully implemented curriculum is a challenging task. People involved in implementing skill standards usually ask a common set of questions: What are skill standards? Do these national standards reflect the skills and knowledge required by local employers? To what extent do these exist in curriculum currently being taught? What needs to be added? What should be deleted from the current curriculum, if anything?

There is a logical sequence of activities when schools and communities move from a well-produced skill standards document to a fully implemented standards-based curriculum. Useful tools have been developed to make the implementation process easier. These tools are adaptable to different skill standards and to varying local program requirements. Some schools develop programs based on the skill standards. Others integrate the standards into existing programs and courses.

Many secondary and postsecondary schools have found skill standards one way to ensure that career preparation programs provide graduates with the skills and knowledge needed to enter and succeed in a career of choice. Still other schools view skill standards as one aspect of a broad-based program review to ensure the goals and expectations of their communities are being met. And recently, elementary and middle school academic teachers have begun to link foundation skills and knowledge of their content areas to skill standards for certain industries.

Some schools have chosen to fully implement all aspects of skill standards-based curriculum as a way to demonstrate that they are engaged in broad-based educational improvement and are a part of education reform. This approach implies major changes in curriculum, instruction, assessment, and professional development. Others integrate skill standards into one specialty class. Some schools chose to implement standards-based curriculum through a competency-based approach. This can require significant investment in professional development and curriculum development activities. Other schools make little change in their pedagogy, focusing on the new content emerging from the standards in their curriculum.

In addition to sharing a common set of questions and working through similar processes of implementation, people new to implementing skill standards share a common set of fears and concerns. The new language of the skill standards and variety of unfamiliar formats can make it difficult for many educators to implement new industry skill standards within their own curriculum development and teaching practices. Many educators have difficulty seeing their schools as one phase of their students' journey along a pathway toward a meaningful career and an economically productive life.

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Having learned these things from the field, we share in this section many examples of the successes people have had in redefining curriculum and instruction around skill standards, and using them to strengthen both academic and technical curricula. Information and examples related to design of standards-based curriculum and teaching strategies are highlighted. This section also includes background information for developing curriculum frameworks, and provides examples of tools and strategies for developing skill standards-based curriculum and teaching methods in both academic and technical settings at a variety of levels.

Key Questions

1. What tools and strategies can be used to structure curriculum to prepare students for workplace success?
2. How can an awareness and exploration of occupations and career paths be deepened and broadened?
3. What might be included in a curriculum framework for skill standards integration?

1

What Tools and Strategies Can Be Used to Structure Curriculum to Prepare Students for Workplace Success?

Educators have created a number of useful tools to ease the processes of integrating standards into existing curricula and developing curricula based on standards. Some tools help educators and employers work as a team to make preliminary decisions about the content of curriculum. Others help determine the nature and placement of content within the curriculum, and help educators build instruction around standards. Examples and case studies are provided to illustrate the many ways educators have used these and other tools and strategies to select, structure, and organize the content of curriculum in programs.

How Skill Standards Can Help

Skill standards can be used to determine what curriculum content needs to be developed. They can also help educators and employers identify the gap between what is taught in schools and what current workers in local industry need to know and be able to do to succeed on the job. Standards can provide a clear set of knowledge and skill requirements to use as a checklist against existing curriculum and the sequence of courses within programs. Teachers can use the skill standards components (tasks, skills, knowledge, behavioral attributes) as a checklist to assess the content of their curricula. In partnership with employers, teachers can analyze their curricula against the standards. They can determine where changes are needed in course structures, content, sequence, and distribution of content and skills within programs, and review the curriculum connections between school-based and work-based learning. Curriculum

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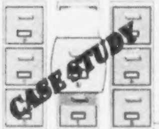
developers and teachers can carry out short- and long-term assessments based on skill standards. They can track the progress of learners at job sites and/or in further education and training to determine if the program content is supporting the learners' career development needs.

Skill standards allows students to reach the depth and breadth of learning required for success in both academic and technical programs. As students learn, they integrate what technical and professional workers need to know and be able to do with targeted academic and employability skills learned in school and on the job. Skill standards, when learned in context, can also be used as a tool to focus on process skills such as problem solving and analysis.

Teachers can use skill standards to help structure their curriculum as they identify important content and processes, develop linkages across important curriculum topics, and search for ways to make their curriculum more authentic and contextualized through scenarios and projects. For example, teachers use skill standards as a basis for curriculum content (e.g., module/lesson plan incorporating skills, knowledge, attributes, tasks, and scenarios) that satisfies academic and technical work requirements. The list of skills, knowledge, and attributes found in most skill standards materials provides a compatible structure for developing crosswalks, and for linking like topics, skills, knowledge sets, and attributes found in competency-based programs. Skill standards can be used to link one academic or employability skill with one skill standard to create examples of applied learning. Applied learning is useful to academic teachers as they struggle to find authentic examples of academic objectives, and to technical educators who want to illustrate how a specific technical skill is used in the workplace. Scenarios, based on validated skill standards, are useful to teachers working to integrate learning. Standards are useful to teachers at all instructional levels in education and workplace settings: they help teachers contextualize learning, design problem-based learning experiences and short-and-long term projects which deepen academic learning, strengthen and reinforce technical learning, and integrate school-based and work-based learning.

Useful Tools and Strategies — First Steps Toward a Skill Standards-Based Curriculum

The following examples illustrate how several curriculum tools and strategies have been particularly helpful to educators implementing standards-based curriculum.



New Hampshire Community Technical College

Using cornerstone courses to drive the program

The program at New Hampshire Community Technical College in Portsmouth, New Hampshire, created its biotechnology curriculum with the focus on technician education and training in the laboratory. The curriculum for each protocol incorporates the appropriate bioscience industry skill standards for each Standard Operating Procedure (SOP). Students receive spreadsheets with this protocol information in order to see the relevance of their education and training to the workplace. *The Virtual Workplace* design fosters a hands-on approach, encourages students' proficiency in biotechnology skills, and creates an environment that allows students to

CASE STUDY CONT'D

acquire the necessary attributes for the industry workplace as they develop throughout the course.

The program includes two 6-credit cornerstone courses that all students must take. Students participate in the first of two experiential courses that introduce them to biotechnology with state-of-the-art tools of the trade. Biotechnology Experience I is a research course which gives students the opportunity to master the skills, knowledge, and behavioral attributes of a biotechnician in an atmosphere that simulates the biotechnology workplace. The course consists of nine hours of hands-on work in the biotechnology virtual laboratory and two hours of formal theory each week. The protocols focus on aspects of the "central dogma" theory of biology (the theory states that DNA carries the code for life, that DNA is transcribed into messenger RNA, and with help of transfer RNA, the messenger RNA is translated into protein).

The Biotechnology Experience II course focuses on manufacturing in the biotechnology industry. The SOPs in this course include those common to the upstream and downstream processing of proteins used in therapeutics, diagnostics, and vaccines, including those employed in fermentation, purification, and quality control of protein production.

The laboratory-oriented courses consist of four modules. Here's a sample from the Biotechnology Experience I course:

- Two weeks of biotechnology overview, including overviews of the industry, the important role of the biotechnician, safety in the laboratory, tools-of-the-trade in biotechnology research, an exercise in the use of pipets, and preparation of reagants, buffers, and media for module 2
- Six weeks of isolation and manipulation of DNA when students isolate and then spool DNA from calf thymus, map a viral genome, learn DNA fingerprinting protocols (including RFLP and PCR techniques, and the Southern technique), clone genes, and control gene expression
- Two weeks of protocol exploration for isolation, identification, and characterization of proteins, including polyacrylamide gel electrophoresis (plus protein molecular weight determination), immunoblot or Western blot, hybridization and probe
- Six weeks of the "middle man in central dogma theory"—mRNA and DNA code and protein product. Students are asked to make tPA in large quantities for medicinal purposes, isolate mRNA from those cells, use reverse transcriptase to create cDNA from mRNA nucleotide code, and clone and amplify cDNA so that nucleotide bases sequence can be determined

The New Hampshire Community and Technical College System

Using a Curriculum Analysis Matrix to strengthen existing curricula

A Curriculum Analysis Matrix was developed as part of the New Hampshire Community and Technical College System's "Using Voluntary Industry Skill Standards in Performance Based-Curriculum Design," Project Fund for Improvement of Post Secondary Education (FIPSE), sponsored by The U.S. Department of Education. (*See exhibit 4A.*) This matrix became a useful tool for educators as they reviewed the courses offered within a program and identified the places in which the skill standards were already taught. New Hampshire technical college instructors used the matrix to begin the process of integrating the Human Services Skill Standards into the human service program curriculum in campuses across the state. (*See exhibit 4B.*) In a three-day workshop session, instructors from all sites reviewed the skill standards and, using the matrix, assessed whether the full bank of skill standards were covered in their program and in which courses they were found.

Using the definitions below, instructors began their analysis by writing in their programs' course titles and course numbers in the column heading provided. To be sure that they could visualize the full impact of the standards on their curricula, they included all of the courses associated with their program. For each skill standards listed in the left column, instructors marked the course(s) which aligned with the standard and assigned a code to identify the extent to which each course introduced the standards, or helped students practice or master the standard.

Code Key:

I = Introduced. In this course the standard is introduced. Students gain knowledge related to the standard and may have an initial experience practicing the skills associated with the standard. The student receives an overview of the standard and its importance in human service work.

P = Practiced. In this course time and opportunity are provided for the student to practice the standard and begin to develop initial skills related to the standard.

M = Mastery. In this course students are expected to demonstrate mastery of the skill standard. It could be the same course in which the standard is introduced or practiced, or it could be a subsequent course. Students are responsible for demonstrating mastery of this standard, and the instructor is responsible for assessment of student performance and mastery on this standard.

N/A = Not applicable. The standard is not part of this course.

Exhibit 4A: Curriculum Analysis Matrix

School: ______________________

Date: ____________

Code Key

I= Introduced

P= Practical

M= Mastered

N/A= Not Applicable

Skill Standard	Course Title:	Course Title:	Course Title:	Course Title:
1.				
2.				
3.				
4.				

Developed by Education Development Center, Inc., 1995

Exhibit 4B: Completed Curriculum Analysis

Community Support Worker Standards
Curriculum Analysis Matrix
Completed Example for Skill Standard #4

School: ______________________

Date: ____________

Competency Area #4:
Community and Service Networking
Knowledge about the formal and informal supports available in community and skilled in assisting participant to gain access to supports

Code Key
I= Introduced
P= Practiced
M= Mastered
N/A= Not Applicable

Skill Standard	Intro - Human Services	Learning & Behavior	Ind. Assess - ment & Plan	Ethical Issues in Human Serv	Supportive Communication	Field Experience	Internship I/II
4A. Initiates or assists in the assessment process by gathering information (e.g. participant's self-assessment and history, prior records, test results, evaluation results, additional evaluation) and informing the participant about what is expected throughout the assessment process.	I		I/P			P	P/M
4B. Conducts or arranges for assessments to determine the needs, preferences, and capabilities of the participants using appropriate assessment tools and strategies, reviewing the process for inconsistencies, and making corrections as necessary.	I		I/P			P	P/M
4C: Discusses findings and recommendations with the participant in a clear and understandable manner.	I		I/P			P	P/M
4D: Provides information about human, legal, civil rights, and other resources, facilitates access to such information, and assists the participant to use information for self-advocacy and decision making about living, work, and social relationships.						I	P/M

Developed by Education Development Center, Inc., 1995

The gap discovery led to program revision. In addition to the intended outcomes of this process, this use of the Curriculum Analysis Matrix yielded unintended but important results, as seen in the completed matrix. One of the required courses in their program (Individual Assessment and Planning) had always been difficult. Teachers had problems teaching it. Students had difficulty when taking the course. No one was sure why. After the Curriculum Analysis Matrix was completed, the instructors in New Hampshire found that more than 60 percent of the skill standards for the human service major were contained within that course. The other 40 percent were distributed among other courses over the two-year program. This finding helped them understand that this course contained too much content for one semester. This analysis helped them make a strong case for changing the course from one semester to two semesters.

Human Services Research Institute (HSRI)

The Course Planning Tool was used as a way to organize instruction related to skill standards

Human Services Research Institute in Cambridge, Massachusetts, held the contract to develop national voluntary industry skill standards for the human service industry, and worked with Education Development Center to develop useful tools to support the implementation process. One part of their project was to develop implementation guidelines for educators and trainers working in programs leading to careers in that industry. Staff from City University of New York in New York, the New Hampshire Technical College in Berlin, and NEKTON/Norhaven, a human service employer in Minneapolis, Minnesota were field test sites. To develop their classes, these instructors used the Course Planning tool to help them think about the kinds of instructional resources they would need, the kinds of activities students would engage in, and how they would assess students' progress toward achieving the standards. Guide questions for completing the tool included the following:

- What instructional resources (e.g., text book(s), articles, book chapters, films, videos, slides, workplace materials, field trips, case studies) will be used to help students develop skills needed for this standard or activity?
- What teaching/learning methodology (e.g., role play, audiovisuals, computer-based learning, demonstration, cooperative team learning, case study, lecture, self-directed study teams, readings, homework, peer teaching) will be used to help students develop the skills needed for this standard or activity?
- How will it be determined that each student has developed the skills required for this standard or activity?
- How will students demonstrate their skill acquisition (e.g., portfolio,

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checklists, major project, reports, performance tests, reports from workplace supervisors and/or participants, observations, oral report, videotape)? Will teachers assess this standard or activity, or will students assess each other? Will workplace mentors or supervisors assess students? What type of records will be kept to document each student's progress on the standards or activities?

- What work-based learning will be required to help students develop the skills needed for this standard or activity?

Guidelines for implementing the community support worker skill standards were developed as a result of this field test process and the feedback received from instructors who used these and similar tools. Note that both this and the Curriculum Analysis Matrix exhibit are shown illustrating the implementation of the community support worker standards. These illustrate how the tools flow from one to the other. When used in the same program, the Gap Analysis, Curriculum Analysis Matrix, and Course Planning Tool form a toolkit useful to program and curriculum developers and to teachers who are planning and implementing programs based on skill standards. (*See exhibit 4C*, a Course Planning Tool completed by one of the human service instructors.)

EXAMPLE

Madison Park Technical Vocational High School - *aligning program standards, industry skill standards, and city learning requirements for the Boston Integration Project*

As part of the Boston Integration Project (BIP), staff at Madison Park Technical Vocational High School in Boston, Massachusetts, used a simple form to align industry skill standards with required program-based vocational and Boston City academic standards. This alignment allowed staff to see the linkages between national industry standards and local learning requirements. This also helped define a structure allowing for the development of scenarios which were used in the latter part of the project to integrate learning.

VOCATIONAL STANDARDS	SKILL STANDARDS	ACADEMIC STANDARDS
Bioelectronics	Bioscience	10th Grade Applied Algebra
Troubleshoot DC Circuits (measure current, voltage, resistance characteristics)	Troubleshoot and repair equipment Instrumentation Troubleshooting ability Problem solving	Process information and communicate ideas using the language of mathematics necessary in their vocational specialty

This alignment is also important in the development of curriculum resources for the academic teacher who is seeking "authentic learning experiences" for traditionally educated academic students.

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Exhibit 4C: Course Planning Tool

COMMUNITY SUPPORT SKILL STANDARDS
COURSE PLANNING TOOL

Competency Area 1: Participant Empowerment

The competent community-based support worker (CBSW) enhances the ability of the participant to lead a self-determining life by providing the support and information necessary to build self-esteem, and assertiveness; and to make decisions.

	INSTRUCTIONAL RESOURCES	TEACHING/LEARNING METHODOLOGY	WORK-BASED LEARNING	ASSESSMENT	COMMENTS
1A. Skill Standard: Assists and supports the participant to develop strategies, make informed choices, follow through on responsibilities, and take risks.	In HUS212: Text: Egan, The Skilled Helper, Exercises in Helping Skills	Brief lecture, extensive role play in classroom, video-taping "helping" interactions + providing feedback; discuss, scenarios, teach decision-making model; students use steps in decision-making process (in written assignments + role play) Practice skills development in HUS 211/212	May occur as part of internship - most likely will occur	observation, audio/video recording, "client" feedback/documentation observation/feedback from supv, "client", peers. Demonstrate brainstorming + screening process; develop pro/con list	
1Aa. Activity: Assists the participant to identify alternatives when faced with the need to make a decision. • Performance Indicators: 1Aa1. Participant reports that the CBSW has helped him or her to identify alternatives when making a decision. 1Aa2 In class, "helper" (CBSW) helps "client" (participant) brainstorm ideas, develop goals - strategies etc 1Aa3 1Aa4	various handouts In HUS211: text: Ethical Decisions in Social Work Practice HUS111 Intro - Various readings				

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Curriculum Models and Frameworks, and Other Development Aids

Guides and tools such as curriculum models, frameworks, and surveys of employers and program graduates help educators develop, and improve curriculum in schools that meet students' and employers' needs and meet industry skill standards. The following examples illustrate the ways these materials have been used by educators implementing skill standards.

EXAMPLE

American Chemical Society (ACS) - *developing a Gap Analysis Tool to align curriculum with industry requirements*

The Chemical Process Industry Skill Standards Project of the American Chemical Society developed a tool to analyze the "gap" between local industry expectations for technical workers and curriculum content of local technical or community colleges. Since then, generic forms of this gap analysis tool have been used by other groups to help educators and industry assess the degree to which they agree about what workers need to know and be able to do. The gap analysis measures current performance against criteria-based standards. It is a self-assessment tool, to be used as a pre-test measure to establish a baseline performance as the first step in revising curriculum using industry skill standards. This tool is easy to administer; it defines technical vocabulary and provides a uniform rating scale with a well-defined code for immediate interpretation. (*See exhibit 4D.*)

EXAMPLE

Center for Occupational Research and Development (CORD) - *an Integrated Curriculum Model for Workforce Education Curricula (ISWEC)*

The Center for Occupational Research and Development project, Integrated System for Workforce Education Curricula (ISWEC), illustrates three types of skills (Core Skills, Broad Technical Skills, and Specialized Technical Skills) built on an academic and career foundation. It shows when the three types of skills are introduced, the extent to which they are covered along the school-to-work continuum, and how they are integrated vertically as well as horizontally. The model also shows school-based and work-based learning in relation to these three categories of skills. (*See exhibit 4E.*) This model corresponds to the clustering concept that calls for the common core of skills and knowledge appropriate to all careers, a more narrowed set appropriate to career majors, and a specialized set appropriate to specific occupations.

Skills and knowledge sets found in national industry skill standards projects can be matched with national academic standards to align as sets or related sets of skills and knowledge. These pairings are useful to guide the development of integrated curricula and applied learning. Several of the industry skill standards projects have merged their standards with others or with academic standards. The CORD ISWEC project, combined national voluntary industry skill standards with national academic standards and developed integrated curriculum standards to guide the development of curriculum for career clusters.

The ISWEC Curriculum Map illustrates the contextualized nature of the curriculum. (*See exhibit 4F.*) It identifies courses which focus on development of knowledge in context; projects organized around integrated curriculum standards or themes; and the relationship of both contextualized courses and projects to pure disciplines and work-site learning. The map is placed on axes providing a range along the integrated learning continuum and time.

Exhibit 4D: Gap Analysis Tool

INSTITUTIONAL CAPACITY/INDUSTRY IMPORTANCE
PART II OF III
Chemical Technician Program Approval Service (CTPAS)
Voluntary Industry Skill Standards Project (VISSP)

A: Industry Partners:
What expectations do you have for the performance orf current technicians on the following objectives?

B: Institutional Partners:
To what extent does our current curriculum address the performance of these objectives?

0=Not Present | 1=Introductory | 2=Intermediate | 3=Advanced Level

OBJECTIVE	A	B	GAP	NOTES
I6.k01.01 Describe the principles of Total Quality Management (TQM)				
L6.k01.02 List and define the steps involved in problem-solving procedures				
L6.k01.03 Construct a process flow diagram; label and describe each of the components as well as the flow chart symbols				
L6.k01.04 Use a process flow diagram to describe a project or an experiment which is being conducted in the laboratory				
L6.k01.03 Identify ways to ensure that a process is in control				

Column A tells us what expectations local industry has for current technical workers in relation to the performance standards of the Chemical Process Industry Skill Standards. Column B tells us to what extent the education institution reflects the performance standards. With information from both of these sections of the matrix the school can determine to what extent its current curriculum meets local and national industry expectations.

In the gap analysis, the "gap" itself is determined by identifying the numerical difference between the industry score and the school score. Using the four-point coding system

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Exhibit 4E: Integrated System for Workforce Education Curricula Model

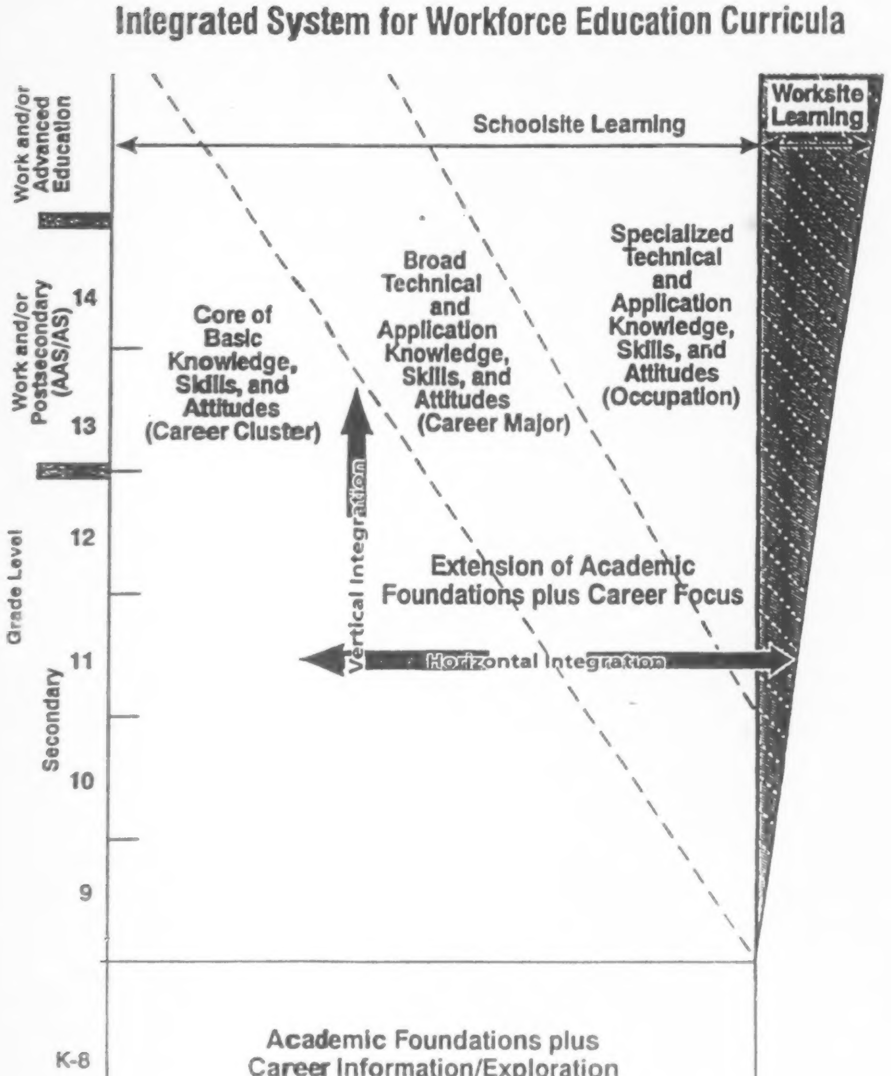
Integrated System for Workforce Education Curricula
Work and/or Advanced Education
Work and/or Postsecondary (AAS/AS)
Grade Level
Secondary
14
13
12
11
10
9
K-8
Schoolsite Learning
Worksite Learning
Core of Basic Knowledge, Skills, and Attitudes (Career Cluster)
Broad Technical and Application Knowledge, Skills, and Attitudes (Career Major)
Specialized Technical and Application Knowledge, Skills, and Attitudes (Occupation)
Vertical Integration
Extension of Academic Foundations plus Career Focus
Horizontal Integration
Academic Foundations plus Career Information/Exploration

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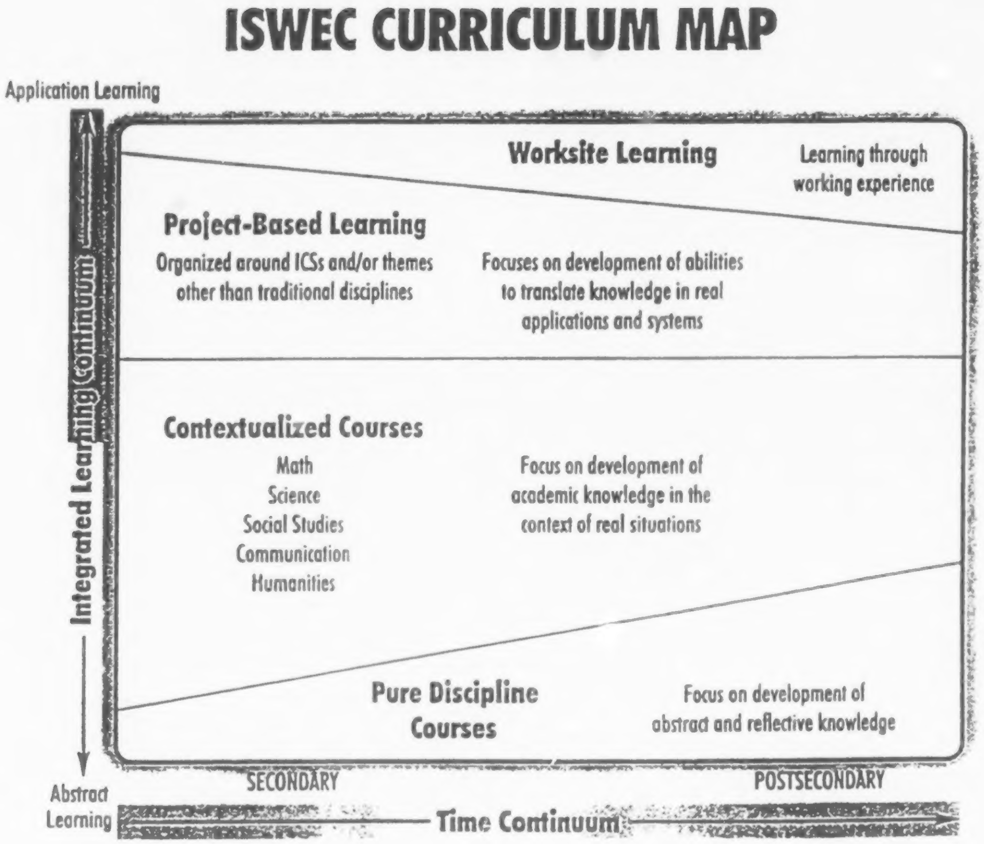
Exhibit 4F: Integrated System for Workforce Education Curricula Curriculum Map


ISWEC CURRICULUM MAP
Application Learning
Integrated Learning Continuum
Abstract Learning
Worksite Learning
Learning through working experience
Project-Based Learning
Organized around ICSs and/or themes other than traditional disciplines
Focuses on development of abilities to translate knowledge in real applications and systems
Contextualized Courses
Math
Science
Social Studies
Communication
Humanities
Focus on development of academic knowledge in the context of real situations
Pure Discipline Courses
Focus on development of abstract and reflective knowledge
SECONDARY
POSTSECONDARY
Time Continuum

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Project SMART (School for Manufacturing and Related Technologies), a collaboration between Youth Opportunities Unlimited, Inc., Education Development Center, Inc., and Cleveland Public Schools, developed a detailed model that listed the programs and courses in a continuum of learning through high school. (*See exhibit 4G.*) Four columns of information are provided. The leftmost column lists required standards and assessments. The second column identifies academies available to Project SMART students the summer before each school year. The center of the model illustrates the school-based learning component in which all required courses are marked with an "*x*." It also lists the years in which integrated projects will be done and the number of guest speakers each student would meet. The last column lists incrementally intensive work-based learning beginning with three field trips in grade 9 and ending with extensive apprenticeship in grade 12. Models allow the reader to view the entire program and the interrelationship of its parts. This is particularly useful when describing complex programs.

NorthWest Center for Emerging Technologies (NWCET) - *the process used to develop high school curriculum based on information technology skill standards*

Models are useful to illustrate a process and to provide information on the specific components of a curriculum. This model provides the reader with information on the process used to develop competency-based curriculum for high schools using information technology skill standards. (*See exhibit 4H.*) The components listed in these process steps provide the curriculum implementer with key pieces of information needed in making implementation decisions. After reading through this model, the implementer will look for certain elements within the high school modules that form this curriculum: core IT skill standards appropriate for high school students; a list of technical knowledge and foundation skills with their corresponding program outcomes, key competencies, and performance indicators; activities and assessments which integrate technical and foundation skills; corresponding math and science competencies and a matrix illustrating the relationship between these IT standards and other academic standards. This information helps the implementer understand the instructional implications of using the modules developed for this high school IT curriculum.

North Seattle Community College Pathway to Success - *illustrates the skill standards as an intended driver of curriculum development in North Seattle Community College's electronics program*

This model illustrates how North Seattle Community College in Washington State, with strong collaboration from the American Electronics Association, engaged in a consensus building process of skill standards implementation which drove curriculum reform in the electronics program. (*See exhibit 4I.*) The model illustrates the role of industry and industry standards along the curriculum development and implementation process. It combines single activities along a linear continuum with several activities which run parallel with each other. The frequent industry involvement and focus on industry standards, as well as the analysis of where they were and where they wanted to be, the development of "the big picture," general curriculum, and "threads" of learning, are examples of the ways this model illustrates the consensus building process that allowed curriculum development and implementation to succeed.

Exhibit 4G: Model School of Manufacturing and Related Technologies

PROJECT SMART
School of Manufacturing and Automotive Related Technologies

Standards and Assessments
Manufacturing Tech. Standards (Scenarios/40)
(Integrated) (OCAPS) Machine Trades
(Integrated) Cleveland Public Schools
(Integrated) Ohio State Proficiency Tests (actual classes that teach the test and summer sessions)

Standards and Assessments		School Based Learning							Work Based Learning (Student is AAA Qualified)
		Math	Science	Soc.Stud.	Eng.	Electives			
9th Grade Standard Assessment AAA	Summer before *Mfg. Academy Intro Experience*	(Alg). X	(Princ. of) X	(Amer. Hist.) X	I X	X	*Integrated Projects/Problems	Guest Speakers (10)	Field Trips: 3 Trips per Student
		Introduction to Technology							
10th Grade *Standard Assessment AAA* *Certificate of Initial Mastery*	Skills Academy Mfg. Academy	(Geo.) X	(Chem.) X	(World Hist.) X	II X	X	*Integrated Projects/Problems	Guest Speakers (10)	Shadowing - 2 per year/student Field Trips: - 2 Trips per Student
		Employability Skills							
11th Grade -MESA Evaluation (Work Samples Inventory) -December Standard Assessment *(Includes technical skills for work based placement)*	Skills Academy Mfg. Academy	(Alg./trig.) X	(Phy.) X	---	III X	X	*Integrated Projects/Problems	Guest Speakers (10)	*Semester 1 - 2 Weeks teams of 2-3 students linked to Smart Lab* *Semester 2 - 10 Weeks (each student has plan and rotates across departments)* *Non AAA qualified students tasks in SMARTLAB*
		SMARTLAB *Major Project Driven* Class and lab based experience mechanical and computer driven equipment							
12th Grade *Certificate of Technical Mastery*	*Mfg. Acad* *Comm. Services Jobs*	(Adv.) X	---	(Amer.Gov./ Economics) X	IV X	X	*Integrated Projects/Problems		*Apprenticeship - (1/2 day)*
		In School Activity							

Note - *8th Grade Curriculum Planting the Seed*

* Drives school based curriculum

Youth Opportunities Unlimited, facilitated by Education Development Center, Inc., 1994

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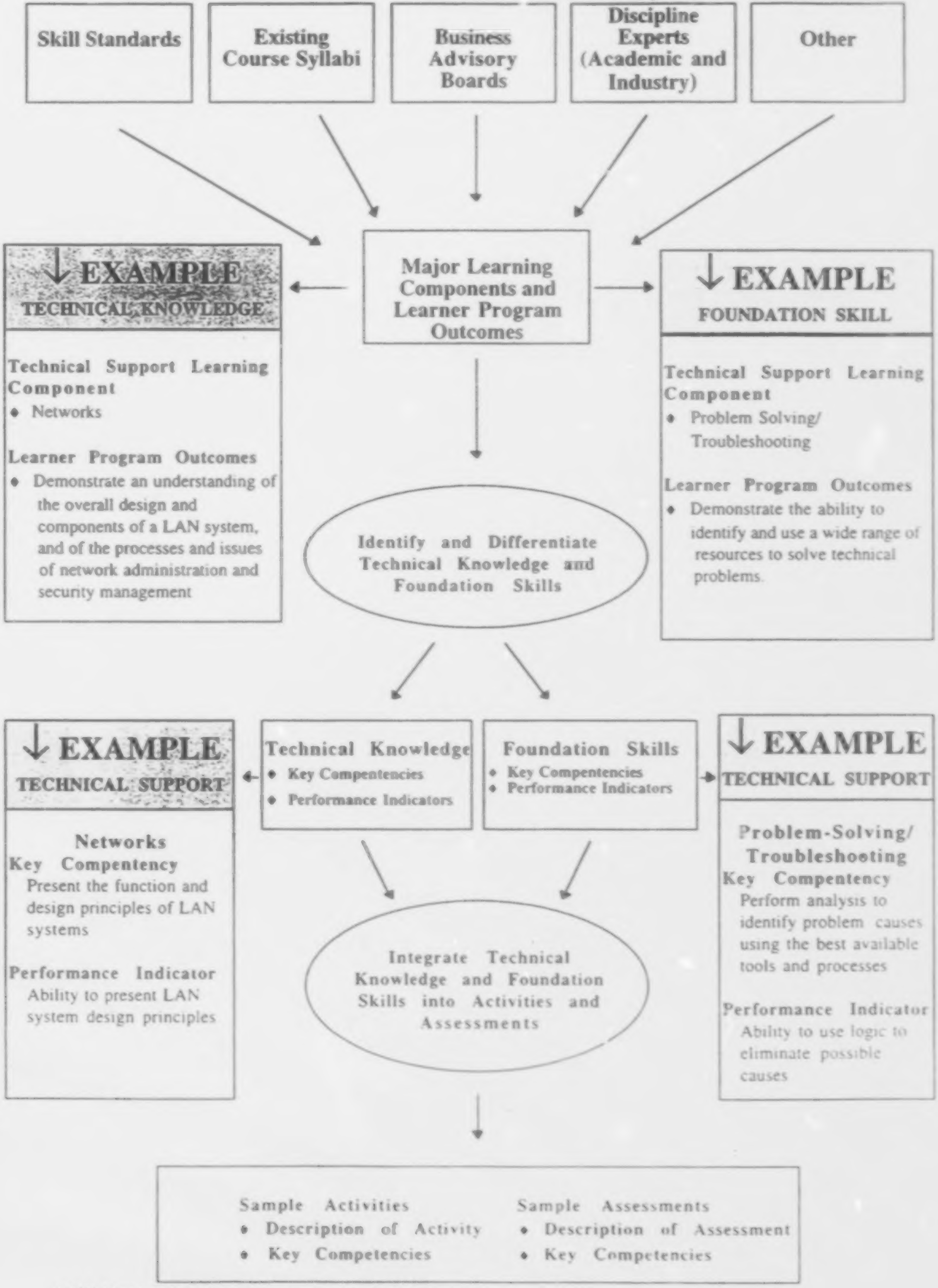
Exhibit 4H: NWCET Curriculum Development Framework



Skill Standards

Existing Course Syllabi

Business Advisory Boards

Discipline Experts (Academic and Industry)

Other

Major Learning Components and Learner Program Outcomes

↓ EXAMPLE
TECHNICAL KNOWLEDGE

Technical Support Learning Component
- Networks

Learner Program Outcomes
- Demonstrate an understanding of the overall design and components of a LAN system, and of the processes and issues of network administration and security management

↓ EXAMPLE
FOUNDATION SKILL

Technical Support Learning Component
- Problem Solving/ Troubleshooting

Learner Program Outcomes
- Demonstrate the ability to identify and use a wide range of resources to solve technical problems.

Identify and Differentiate Technical Knowledge and Foundation Skills

Technical Knowledge
- Key Compentencies
- Performance Indicators

Foundation Skills
- Key Compentencies
- Performance Indicators

↓ EXAMPLE
TECHNICAL SUPPORT

Networks

Key Compentency
Present the function and design principles of LAN systems

Performance Indicator
Ability to present LAN system design principles

↓ EXAMPLE
TECHNICAL SUPPORT

Problem-Solving/ Troubleshooting

Key Compentency
Perform analysis to identify problem causes using the best available tools and processes

Performance Indicator
Ability to use logic to eliminate possible causes

Integrate Technical Knowledge and Foundation Skills into Activities and Assessments

Sample Activities
- Description of Activity
- Key Competencies

Sample Assessments
- Description of Assessment
- Key Competencies

NorthWest Center for Emerging Technologies, 1996

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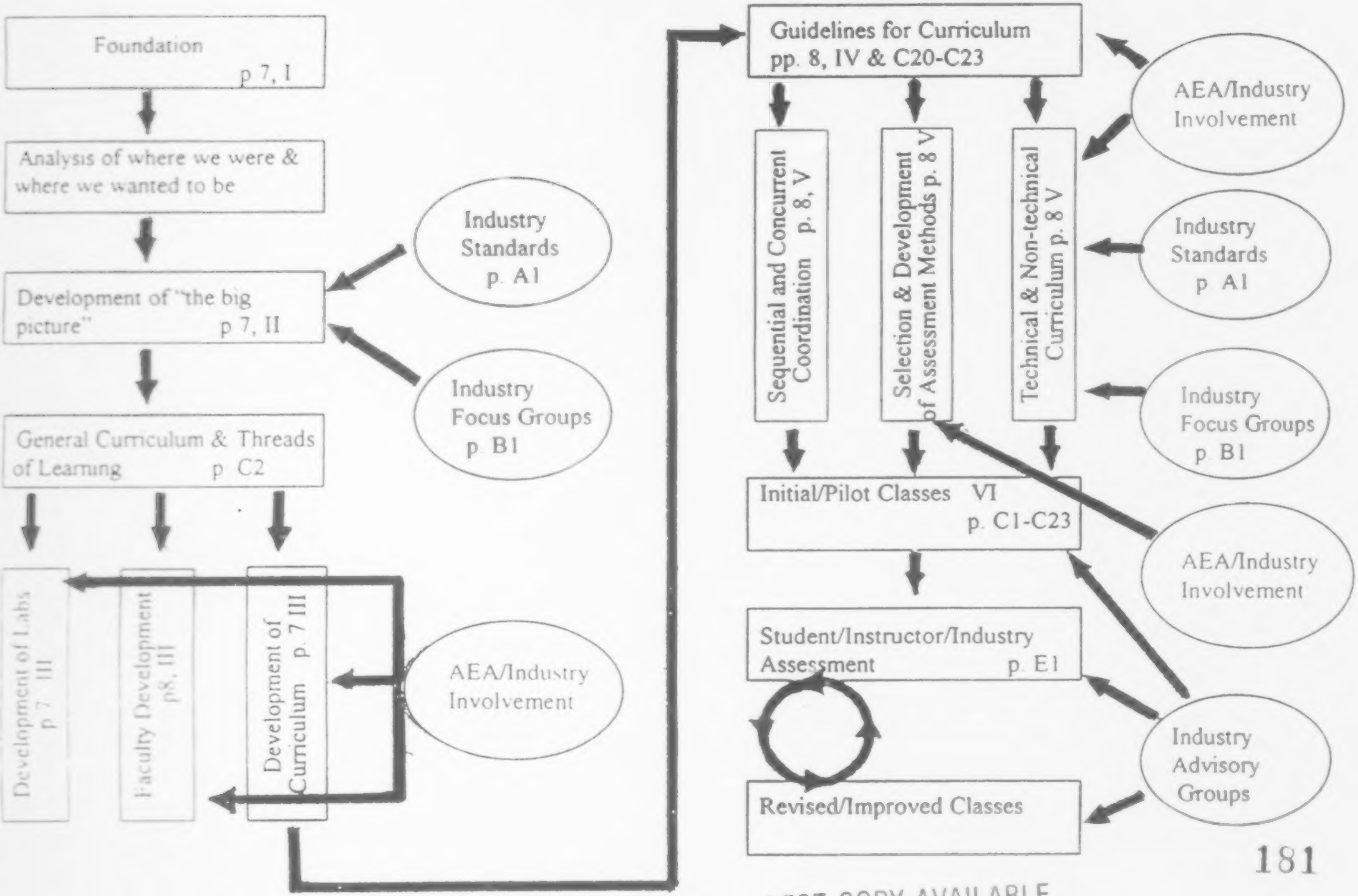
Exhibit 4I: Pathway to Success


Foundation p 7, I
Analysis of where we were & where we wanted to be
Development of "the big picture" p 7, II
General Curriculum & Threads of Learning p C2
Development of Labs p 7 III
Faculty Development p8, III
Development of Curriculum p. 7 III
Industry Standards p. A1
Industry Focus Groups p. B1
AEA/Industry Involvement
Guidelines for Curriculum pp. 8, IV & C20-C23
Sequential and Concurrent Coordination p. 8, V
Selection & Development of Assessment Methods p. 8 V
Technical & Non-technical Curriculum p. 8 V
AEA/Industry Involvement
Industry Standards p. A1
Industry Focus Groups p. B1
Initial/Pilot Classes VI p. C1-C23
AEA/Industry Involvement
Student/Instructor/Industry Assessment p. E1
Revised/Improved Classes
Industry Advisory Groups

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North Seatle Community College, 1998

EXAMPLE

Project SMART Curriculum Map - *used by the SMART teaching team to map out their curriculum and to find ways to support interdisciplinary instruction*

Curriculum Maps help teachers visualize complex learning paths and chart the flow of curriculum. During the first year of Project SMART, teachers created a curriculum map to help begin the process of developing interdisciplinary projects *(See exhibit 4G)*. Their curriculum map consisted of a table with ten columns, each representing a month of the teaching year. Rows were identified by the ninth-grade courses they taught (English, mathematics, physical science, civics, technology, think course). Veteran teachers found this task an easy one, taking about 20 minutes to write in the flow of topics within their curriculum from September to June. New teachers needed more time and had to refer to existing curricula and texts. Once the map was completed, the team marked critical events which took place each school year and which might impact their ability to carry out a project. For example, these Ohio teachers marked the month in which students were required to take the Ohio Proficiency Test. Knowing the date, they were able to spend time before the test to help students prepare. The second step was to review the full map to see where topics of different courses were aligned across the curriculum and could provide a vehicle for interdisciplinary learning. The third was to look over the map to find places in the curriculum where a shift of topics would facilitate interdisciplinary activities, be mutually supportive of each other's curricula, and focus the overall curriculum for students.

Sample Curriculum Map

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
English										
Physical Science										
Algebra 1										
Civics										
Think										
Technology										

EXAMPLE

Alamance Community College - *using an employer survey to test customer satisfaction with graduates*

At Alamance Community College (ACC) three-year postgraduate surveys of employers and graduates are conducted to assess program graduates, employer satisfaction, relevance of training, and graduates satisfaction with career choice. The survey asks employers to respond to the new worker's technical performance on the job in relation to specific biotechnology work skills, competencies, and knowledge. (*See exhibit 4J.*) Every five years the college conducts a workforce study to assay current and projected employment needs and skills. This information is used to inform the design and revision of curriculum.

EXAMPLE

NorthWest Center for Emerging Technologies (NWCET) Curriculum Development Kit - *provides models and steps for developing competency-based information technology curriculum*

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Exhibit 4J: Employer Evaluation of Graduate Questionnaire
Biotechnology 1994

Please use a number 2 pencil and darken in your response on the enclosed answer sheet using the following rating scale.

A = Excellence
B = Above Average
C = Average
D = Below Average
E = Not Applicable

OVERALL PERFORMANCE

1. Learning Ability
2. Dependability
3. Attendance
4. Work Attitude
5. Work Quality
6. Judgment
7. Written and Oral Communication Skills
8. Computational Skills
9. Human Relations Skills

TECHNICAL PERFORMANCE - Samples of Work Skills, Competencies or knowledge:

1. Separate components of a mixture by various chromatographic methods.
2. Perform enzyme assays.
3. Purify and manipulate plasmid DNA.
4. Purify and characterize proteins.
5. Describe molecular mechanisms of inheritance and gene regulation.
6. Operate a spectrophotometer and perform spectrophotometric measurements.
7. Analyze DNA and protein by gel electrophoresis.
8. Aseptically perform the procedures necessary for the successful development of an antibody producing bybridoma.
9. Demonstrate an understanding of the biological effects resulting from the exposure to and the safe handling of radiation sources.
10. Work within the framework of the concepts of quality assurance and quality control.
11. Standardize, operate and interpret the results of basic equipment.

The Northwest Center for Emerging Technologies (NWCET) presents its curriculum model with examples. (*See exhibit 4K.*) This illustrates how skill standards, existing course syllabi, advisory boards, discipline experts, and others provide input into the development of major learning components and learner program outcomes. It shows examples of key competencies and performance indicators of technical knowledge and foundation skills related to information technology skill standards. It illustrates how these are integrated into activities and assessments. NWCET's Curriculum Development Kit (CDK) provides background material, steps, and examples to guide the curriculum developer through the process of crafting competency-based curriculum organized around information technology skill standards.

Integrated Standards

Integrated skill standards provide a unique opportunity to frame education and training programs in new ways, asking learners to draw upon their academic, technical, and interpersonal skills to solve real problems that arise in the workplace. Integrated skill standards promote equity by reflecting the reality of the workplace, setting clear and high expectations, increasing options. and encouraging new teach/learning strategies and alternative assessments. They allow learners to demonstrate mastery of the teaming skills needed in life and work, use a variety of learning styles, and make connections which promote innovation and creativity.

CASE STUDY

Education Development Center, Inc. (EDC)

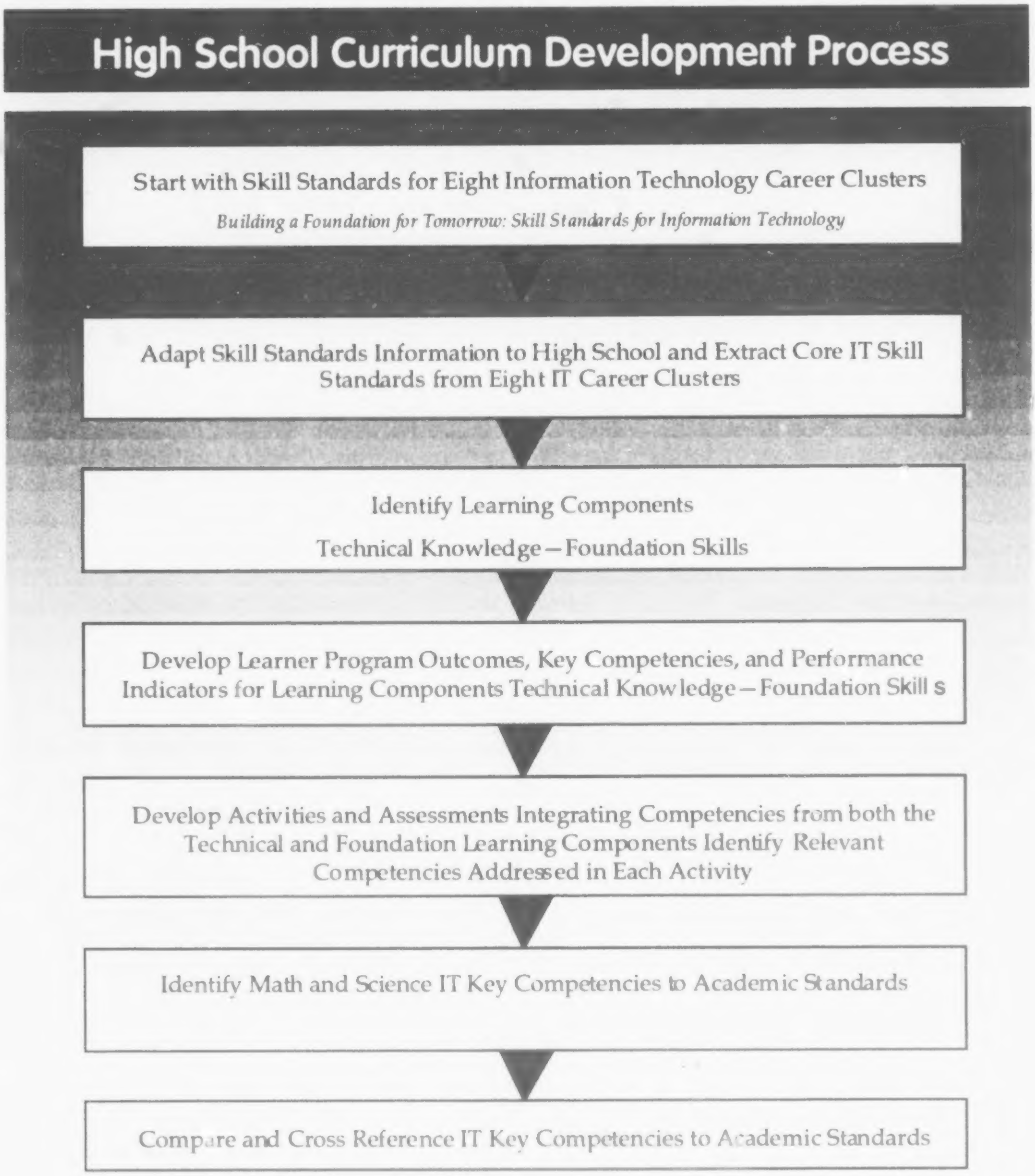
Education Development Center has developed an Integrated Industry Skill Standards (IISS) model that draws on the best learning from education and workplace reform. Two elements that have important implications for equity are the concept of a *Learning Occupation* and the IISS itself.

The Integrated Industry Skill Standards model

The concept of a learning occupation is commonly used in European countries to train youth apprentices. It is a fictitious construct that does not exist in the workplace, but is a real outcome goal for education and training. It combines all the knowledge, skills, and attributes required to perform the full range of tasks conducted by a group of related real-life occupations. By preparing for a training occupation, a person will be more extensively qualified for work in a number of different but related jobs within an industry. They will be positioned to move into a variety of career paths. A cross-trained worker is more productive in a workplace where teamwork is required, or where job rotation occurs. A person prepared for a training occupation is also better able to adapt to new technologies or work systems, or to new jobs in restructured work organizations.

For example, the learning occupation for the bioscience industry is defined as follows: *The Bioscience Technical Specialist I performs experiments and assays, manufactures products, or assists with research, using a variety of technical skills under supervision.* Nineteen entry-level laboratory-based jobs which share a common foundation of skills and knowledge requirements comprise this training occupation. Some of these include animal technician,

Exhibit 4K: High School Curriculum Development Process



High School Curriculum Development Process

Start with Skill Standards for Eight Information Technology Career Clusters

Building a Foundation for Tomorrow: Skill Standards for Information Technology

Adapt Skill Standards Information to High School and Extract Core IT Skill Standards from Eight IT Career Clusters

Identify Learning Components

Technical Knowledge—Foundation Skills

Develop Learner Program Outcomes, Key Competencies, and Performance Indicators for Learning Components Technical Knowledge—Foundation Skills

Develop Activities and Assessments Integrating Competencies from both the Technical and Foundation Learning Components Identify Relevant Competencies Addressed in Each Activity

Identify Math and Science IT Key Competencies to Academic Standards

Compare and Cross Reference IT Key Competencies to Academic Standards

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assay analyst, clinical/medical lab technician, cyto-prep technician, manufacturing operator, pilot plant operator, and research technician. The training occupation crosses the sectors of biotechnology, pharmaceuticals, and clinical laboratories.

The IISS consists of a number of structured scenarios which represent typical, real-life work problems; the skills, tasks, knowledge, and attitudes embedded within that problem; and the criteria for successful mastery of those work tasks.

One of the IISS for bioscience includes the following problem:

> One part of your laboratory responsibilities is to safely unpack and process biological samples. Demonstrate everything you would do to accomplish this. While unpacking samples one morning, you notice that one of the samples is leaking from the container. According to regulations, what should you do?

This problem challenges the learner to think and act. Tasks include (a) take and document corrective action according to Standard Operating Procedure or as directed; (b) notify appropriate person about problems and observations; (c) document communication of information; and (d) maintain professional demeanor. Some of the industry related skills to be demonstrated include aseptic technique, basic laboratory procedures, recognition of environmental hazards, stress management, and troubleshooting.

By focusing on the problem, individuals are required to rise from demonstrating mastery of isolated tasks to demonstrating mastery within the context of a real workplace problem. This larger definition of standard allows for individuals with varying approaches to problem solving and task mastery to *work through to the solution* and increases the chances that they will succeed in education, training, and workplaces. The problems are constructed deliberately to offer more than one right way to master a task and have the work done well.

Project SMART Integrated Skill Standards - *locally developed skill standards for manufacturing*

During the first two years of program planning and implementation for Project SMART, manufacturers in northeast Ohio brought together their most valued frontline workers to participate in several intensive focus sessions to answer this question: What do the most successful frontline workers in manufacturing need to know and be able to do to succeed on the job? Their first step was to come to consensus around the duties, tasks, skills, and knowledge needed in manufacturing. Next, they brainstormed about the types of problems frontline workers were called upon to solve during their first three to five years on the job. What emerged was a set of workplace scenarios which captured the technical, academic, and interpersonal skills that manufacturing workers needed. The following is an example of the workplace scenarios:

Your company makes a medical instrument that gets soldered, polished, cleaned, and then chrome-plated. This plated subassembly then gets inspected and, if it passes, goes into the stockroom. Batch sizes are typically around 25 instruments.

At a later date, you receive a work order to build these 25 subassemblies and additional components into a final product—finished medical instruments. When assembling the instruments, 5 of the 25 instruments you are building appear to have cracked solder joints. You twist the joints with your hand to test them further and sure enough, the parts come loose. What types of changes in the process can be implemented to catch this failure at the preferred subassembly level? What steps need to be taken to look into this and find the root cause of the problem? What should be done to ensure that this does not happen again?

EXAMPLE

Ohio's Integrated Technical and Academic Competencies (ITAC) - *guiding skills training career programs*

The State Department of Education in Ohio is developing a set of ITACs which include competencies that specify what individuals need to know and be able to do to be successful—educationally—in the workplace and in life. ITACs are organized with core competencies, cluster competencies, and competencies identified for specialized occupational programs. (*See exhibit 4L.*) Ohio is in the process of developing ITACs which will replace existing OCAPs (Ohio's Competency Analysis Profiles) currently used to guide skills training programs in vocational education.

Scenario Learning: Crafting Standards-Based Learning within Contextualized, Authentic Situations

Moving from an integrated curriculum model to contextualized instruction in a classroom is challenging to many educators. A comfortable venue for integrating academic and industry skills is through scenario learning. Scenarios describe real work situations, including a routine procedure and an unanticipated problem. They illustrate the ways that real work is done, and the ways that academic, technical, SCANS, and higher-order thinking skills are integrated on the job. Scenarios developed by teacher or front line worker teams are useful in integrating academic, technical, and employability skills within the curriculum. Scenarios have many uses; for example,

- workplace/skill standards
- assessment
- instructional
- application

Problem-based scenarios are becoming a popular and comfortable way for educators to integrate academic and skill standards. Problem scenarios are authentic real-life or work situations which place skills and knowledge in the context where mastery of routine performance must be demonstrated and a problem must be solved.

Exhibit 4L: Career-Focused Education Model

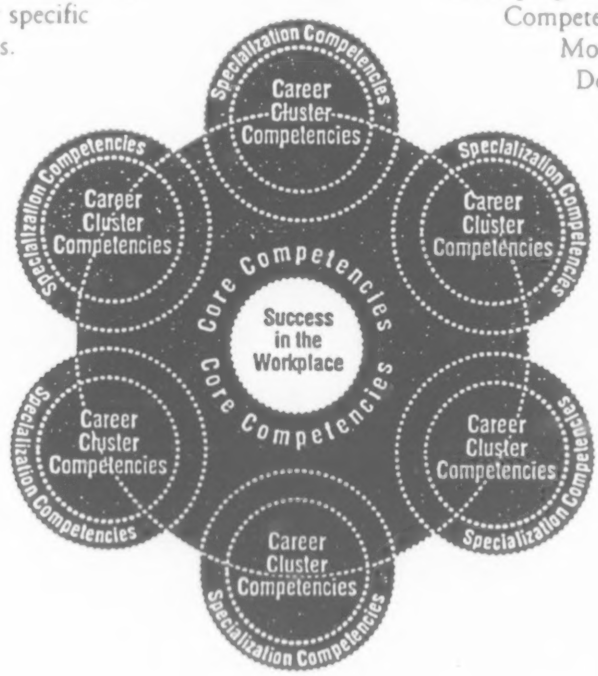
The Career-Focused Education Model—

- strengthens teaching and learning;
- expands options for achieving career and educational goals for *all* students;
- builds partnerships between education and business & industry;
- prepares students with a broad base of transferable workplace skills; and
- integrates academic, employability, and technical competencies.

This model comprises a series of Integrated Technical and Academic Competencies (ITACs), moving from skills common to all careers, to skills for a particular career cluster, and finally to skills for specific occupational specialties.

The ITAC development process includes the following steps:

- Staff review and synthesis of national skills standards, industry certification requirments, and Secretary's Commission on Achieving Necessary Skills competencies
- Review of the synthesized competencies by teachers–both vocational and academic
- Updating and validation of the synthesized competencies by representatives from business and industry
- Identification of direct links to existing and developing state models (Ohio Competency- Based Education Models, Ohio's Career Development Model, Ohio's Work and Family Curriculum)



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Ohio State Department of Education, 1998

Workplace/Skill Standards Scenarios
These scenarios illustrate the integration of the skills and knowledge needed by workers to solve the problems found on the job. The skills and knowledge are presented with the complexity and depth found in real workplaces.

Bioscience Skill Standards
One part of our laboratory responsibilities is to safely unpack and process biological samples. Demonstrate everything you would do to accomplish this. While unpacking samples one morning, you notice that one of the samples is leaking from the container. According to regulations, what should you do?

Assessment Scenarios
These scenarios specifically assess skill and knowledge levels on targeted standards. They are accompanied by rubrics and examples of answers which meet specific assessment criteria.

Far West Laboratory , Career-Technical Assessment Program (C-TAP)
You are an employee of a local convenience store. The store has experienced shoplifting in recent months, threatening store security and sales. A previous part-time evening employee was fired because his efforts to maintain store security offended customers and hurt sales.

Your assignment is to train the replacement evening employee. Your boss has asked you to emphasize policies and duties specifically related to customer relations and store security. The challenge you face is to balance the store's need for good customer relations and for effective risk management.

Instructions: Think about all you know regarding risk management, security and loss prevention, and customer relations. Describe what you would say to the new employee as you conduct the training. In your description, be sure to include store policies and procedures that deal with risk management and customer relations.

To receive a proficient rating on this task, you must show all of the following:

- knowledge of risk management, security and loss prevention, and customer relations;
- ability to propose a solution to this scenario;
- ability to communicate effectively in writing.

Instructional Scenarios
These scenarios illustrate how to integrate academic standards, employability skills, and skill standards around an authentic problem which is presented at a developmental, cognitive, social, and technical skill level appropriate to the students involved in learning. Instructional scenarios are designed to be the focus of problem-based learning and projects.

YFC Out-of-School School-to-Work Program
Your company has a goal of zero defects. During the end-item audit by quality control, bent and/or misaligned pins are found in a circuit board that was assembled by your team. All modules were then pulled from stock, inspected, and repaired prior to shipping. Manufacturing instructions were provided, indicating proper placement of

electronic components (the assembly tasks were to insert electronic components into their proper sockets to meet manufacturing specifications). You are confident that your team is inserting the components properly.

Your company's current approach to solving problems is to ask, What are the corrective steps that need to be take to prevent this quality defect from happening again? Is assembler retraining needed? Is this a people problem or a process problem? Is a design change needed (e.g., should components be soldered in place)?

Work with your team to determine why this is happening. Answer the preceding questions with your team members and write the paperwork for engineering to look more deeply into the problem. Devise a plan to include a second inspection prior to final assembly.

Applied Learning Scenarios

These scenarios usually illustrate how one skill or piece of content knowledge is applied on the job.

Workplace Applications - South King County

Math:	Ratio and Proportion
Company:	Sun Sportswear
Submitted by:	Suzanne Saterlee, Arts & Communication Team
Application:	Mixing colors for the screen printing process
Description:	A Sun employee must be able to mix custom colors for screen print applications
Suggested Activity:	Custom dying eggs. With the four basic food colors, determine the ratio of blue to red to yellow to green for various custom colors. Double or triple the size of the dye batch. The custom color should remain constant if the ratios have been followed. Colored frosting. Using basic white frosting as a base, use the color ratios to tint the frosting and frost some sugar cookies. The student could then develop a stencil and screen-print the cookies.

For purposes of curriculum development, instructional and assessment scenarios play a major role. The ideal instructional scenario builds upon students' acquired skills, introducing the desired skill standard and complementary academic skills and knowledge within the context of the desired industry. At certain levels (career awareness, exploration, 9th grade), instructional scenarios might be focused on broader issues affecting workplace success and more generic employability or SCANS skills. In many cases, an instructional scenario will focus on the skills to be developed, and can be organized around academic content supporting the industry focus. Assessment scenarios are constructed for the purpose of assessing learner progress in skills, knowledge, and attributes. (Assessment scenarios are discussed in the Section 7.)

Criteria for Scenario Development

Good criteria help make strong scenarios which accomplish intended goals of instruction. To ensure depth and consistency of scenarios used in skill standards-based curriculum, the following criteria have been developed by Education Development Center, Inc.

As a general set of guidelines, each scenario should

- contain a challenging problem;
- be interesting and motivating;
- be clearly written and understandable;
- contain sufficient information to use as a base for a learning activity;
- deal with important subject matter that requires serious thought;
- reflect authentic workplace or other real-life situations;
- integrate appropriate academic content;
- integrate appropriate technical skills;
- include content and/or process skills;
- reflect SCANS;
- be applicable to more than one industry.

In addition, educators need to look across the bank of scenarios used to represent their program to determine if the scenarios

- cover a sufficient range and balance of content standards required in a variety of careers and life or work settings;
- cover a sufficient range of local academic learning standards;
- cover a sufficient range of technical skills;
- provide opportunities to demonstrate performance;
- reflect equity and diversity by focusing on a variety of names, situations, and images that are drawn from different ethnic, cultural, gender, racial, and social class groupings.

Instructional scenarios grounded in industry skill standards allow students to experience the integration of required industry skills with academics, interpersonal skills, technical knowledge, and higher-order thinking skills. (*More on scenario learning follows in the Creating Instructional Strategies section.*)

EXAMPLE

Project SMART - *standards-based workplace problems link academic and skill standards*

In their simplest form, workplace problems provide excellent examples of how academics are used in work settings. When designed to join both academic and skill standards, they can be extremely powerful tools for applied learning as well as valuable enriching contexts for abstract concepts. These workplace problems can be used in classes, shops, and work-based learning settings to illustrate how specific skills are used by technical and professional workers. The following example was developed by frontline workers in northeast Ohio. It combines specific manufacturing standards with mathematics.

Scenario 3

Produce a sketch and manufacturing plan for 25 locator plates made of aluminum and measuring 1.00 x 2.50 x 3.50. Three holes measuring .375 diameter are to be drilled through the 2.50 x 3.50 side equidistant on a 1.50 bolt circle which is centered on the side. One hold must intersect the diagonal. Work is to be performed on a computer numeric-controlled (CNC) vertical milling machine. Manufacturing plan should include CNC program.

EXAMPLE

Family and Consumer Sciences (FACS) Skill Standards Project - *including scenarios in standards format*

Constructing workplace problems can be challenging. The Family and Consumer Sciences group designed the following approach for skill standards, which include workplace problems related to standards learned.

Family and Consumer Sciences
National Standards Format
A Compendium of Voluntary Standards Developed by States

Standard: (What is to be learned)
Measurement Criteria: Indicators of the Level of Attainment

Competencies/Content/ Knowledge/Skills	**Process/Higher Order Thinking Skills**	**Related Academics Statements**
(Competencies include the content, knowledge and skills required as subsets of the standards)	(Processes address the higher order thinking skills, reasoning, problem solving, etc. A construct/taxonomy will be established with stems to assist with the development of the elements in this column for both core and clusters)	(Related academic statements will be developed using U.S. Department of Education/V-TECS/IEL Academic Proficiencies Document, that is based on V-TECS/Snyder Taxonomy and Academic Standards identified by Mid-continent Regional Education Laboratory (McREL)

Scenarios: (Authentic situation in which a problem is to be solved.) The scenario allows for content to be learned through problem solving. Competencies, processes, and related academics would be the elements upon which the scenarios would be built. The Scenarios will be authentic and come from beyond the classroom.

At the local level this same alignment process can help integrate academic and vocational instruction within technical or vocational schools.

The curriculum designer and developer can strengthen academic learning by aligning relevant skill standards with academic requirements and creating problems for students to solve

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within the curriculum, which requires students to simultaneously learn and practice both. Academic teachers are seeking these authentic examples to help students master content contained in required material. These examples also support service learning by helping students learn about industries in their communities and the ways people work. Examples of the real problems faced by technical and professional workers bring a sense of reality to the classroom and help students answer the commonly asked question, "Why do I need to learn this anyway? I'll never need it when I get out of school."

EXAMPLE

North Seattle Community College and the American Electronics Association - *partnering in standards-based reform*

In a partnership with the American Electronics Association, North Seattle Community College (NSCC) in Washington State redesigned their program to align better with the electronics industry and strengthen both the academic and technical learning within their programs. Their project holds the following assumptions about curriculum, and how the courses will be designed and taught.

- Strengthen and integrate academic requirements;
- Connect academic concepts to technical subjects;
- Build upon common set of standards and skills;
- Be broad based in general skill areas;
- Have flexibility (modules, articulation, exportable, multiple entry points);
- Provide concurrent course links;
- Provide sequential links;
- Include a variety of experiences for diverse learners;
- Craft methodologies that increase retention of women and students of color.

This effort is driving standards-based reform at NSCC. Components of the new curriculum include the following:

- Course outline including a course description, outcomes, and methods of assessment/ evaluation;
- Sample syllabus to further clarify to the student how the course will meet all outcomes, standards, etc., as specified in the course outline;
- Sample lesson plans, assignments, and exams;
- Labs or activities providing an example of the type of lab experiences needed to convey the skill level, process, or application the student will master;
- Coordinated labs which are team-taught and provide the student with an experience that integrates the concepts taught in a group of courses designed to be taken at the same time;
- List of standards covered in the course, including mathematics, AEA, and others that might apply;
- Concurrent coordination of concepts and topics including at least two beyond the coordinated labs;

- Sequential coordination which describes sequential courses and threads of learning.

North Seattle Community College has developed a Pathway to Success for their program. (*See exhibit 41.*)

2

How Can an Awareness and Exploration of Occupations and Career Paths Be Deepened and Broadened?

For many years administrators, teachers, counselors, and support staff responsible for assisting students through the career development and decision-making process have helped students learn about the world of work, by providing them with information about jobs, education and training needed for various careers, and opportunities to hear guest speakers, tour work sites, shadow people on the job, and engage in mentoring activities. More recently, the growing popularity of the value of work-based learning has allowed more students to experience the world of work while still in school. Until recently, many of these experiences occurred without benefit of well-constructed curricula, and without specific strategies shared by educators which draw authentic workplace learning experiences into academic and technical classes. To make good career decisions, students need current and accurate information about what people need to know and be able to do to succeed in highly technical and rapidly changing workplaces. To become "advantaged" upon graduation, students also need to have experienced integrating skills and knowledge within workplace contexts.

How Skill Standards Can Help

Structuring career awareness and exploration curricula around skill standards assures the curriculum developer that students are getting accurate information about the skills and knowledge they need to enter into and succeed in future careers. By discussing and reviewing skill standards, students can better understand the kinds of skills and knowledge they would need to master and the types of education and training programs which lead to those careers. This useful information helps focus students' career exploration on aligning industry required skills and knowledge with their own interests as they explore career pathways, make preliminary career decisions, and choose education and training options. Using skill standards as focus topics for guest speakers, research questions for industry site visits, and shadowing experiences deepen and enrich those experiences while helping students understand the relevance of their academic curricula. Skill standards can increase awareness of which skills are used in a particular work setting as well as help define the knowledge, attributes, and tasks in industry terms.

Techniques for Building Career Awareness and Exploration

Following are techniques used in creating or revising curricula for career awareness and exploration. They contribute to a better understanding of how career awareness and exploration activities can be made stronger, richer, and more relevant by linking them more closely to the real work tasks, skills, and knowledge sets that are expected of workers in specific industries.

Case Studies

All students need to have an accurate and clear picture about what people do when they work. In *Building a Foundation for Tomorrow: Skill Standards for Information Technology,* the information technology skill standards developed at the Northwest Center for Emerging Technologies, each of the nine occupations presented includes a case study which describes the focus and nature of work for that occupation. One sample case study is the Interactive Digital Media Specialist. (*See exhibit 4M.*)

Mentoring

Mentoring has been found to have a significant positive impact on students and adults learning about careers. At Abraham Lincoln High School (ALHS) student teams are matched with a mentor who is a researcher at a university or in industry. They maintain e-mail contact with their mentor throughout the year. Students visit the laboratory and interview the researcher/mentor with a set of standard questions. At the end of the mentorship, students present a report on their experience that includes photographs, descriptions of the research, and the types of skills required to work in the laboratory.

Market Analysis

Students in the Department of Medical and Research Technology at the University of Maryland School of Medicine track and analyze the stock of selected biotechnology companies and give a presentation to the rest of their class about their chosen company. This helps all of the students develop a feel for what and how well individual companies are doing, as well as general industry trends and issues.

Protocols

Industry-based instructors at San Diego City College introduce students to actual protocols used in industry laboratories. Although these protocols are simplified for students, and any proprietary information is deleted, students gain firsthand experience with actual workplace practices, materials, equipment, documentation, and safety practices. The "wet" materials, plastics, glassware, and soon-to-expire biologicals that these protocols require are donated by employers. In addition to using actual SOPs, students learn to use the same reference materials that employees rely on—company catalogs; textbooks are rarely used.

Notebooks

The program at New Hampshire Community Technical College focuses on teaching students the lab skills that reinforce what occurs in the workplace. All labs require students to be able to identify protocols, the materials needed, the lab skills used, and the safety precautions required. Students maintain all this information in their lab notebook. Every student learns to operate, calibrate, and troubleshoot the equipment in their lab. Each student masters a particular piece of equipment, and some specific protocols, and is then responsible for training all of the other students in its use.

Scenarios

Scenarios are becoming a popular way to help students in traditional academic programs make the connections between their academic learning and the world of work. One example of a

Exhibit 4M: Interactive Digital Media Specialist

Creates, designs, develops, and produces digital media products, which integrates any combination of audio, video, graphics, test, and animation (Sample titles: Animator, Artist/2D/3D, Audio/Video Engineer, Designer, Multimedia Authoring Specialist, Multimedia Programmer, Production Assistant).

As an Interactive Digital Media Specialist, your task is to present information in an interesting, compelling manner. Duties may include creating or developing animations or two- or three-dimensional art for training videos, trade show displays, or your company's Internet page. You often originate content, but typically you will work around constraints you have been given.

For any given job, you analyze the best format to present the information, decide what platform you will use (print, online, video), and determine the desired result and how to measure if you have achieved it. Before you jump in, you estimate how long the job will take and whether to call in additional help from outside your company. The scope of the project and the budget often determine this for you.

During the design phase of the project, you set the tone and pace, select colors, and create a visually appealing layout or stage. For on-line or long print pieces and video shoots, you'll create storyboards—visual examples of the relationship of the pages or the sequence of camera angles and subjects.

The tools you use change at an incredible pace, and so you tend to stay informed about upcoming software and hardware equipment that can make your job easier or enhance the presentation of the material. In a world driven by moving images, you strive to offer something new and exciting to capture the attention of your company's target audience.

After you have created the piece—whether in print, on-line, or video—you will proof print pages, test hypertext links and sequencing of on-line pieces, and edit and refine the video work.

strong academic curriculum that illustrates this is Chemistry in the Community (ChemCom) by the American Chemical Society (ACS). It is a yearlong high school chemistry course for college-bound students. The chemistry is organized around societal issues presented in scenario format. The course features decision-making activities which give students practice in applying their chemistry knowledge in decision-making situations. Another example is Modeling Our World, a high school curriculum for grades 9–12, developed by the Consortium for Mathematics and Its Applications (COMAP), Inc. In this curriculum questions about the real world come before students learn the mathematics they will later apply. Students analyze situations and apply the mathematical concepts needed to solve problems. Contextual questions drive the mathematics learning.

Tyngsboro High School

Human services skill standards as a vehicle for career exploration

Tyngsboro High School, in Tyngsboro, Massachusetts, designed their entire school-to-career initiative around core life skills found in the human services skill standards. After an intensive orientation to the skill standards, the planning team at Tyngsboro High School felt these standards captured a common core of skills essential to the personal and career success of all high school students, and would be useful as a base from which to explore other career specialties. In addition, they thought these skills complemented the existing required English curriculum, thereby providing a comfortable point of integration which would have an impact on all students in the school.

The standards became a vehicle to enrich and strengthen the existing curriculum, rather than an "add-on" to the teachers' already full plate of responsibilities. This was important to teachers who were struggling to implement new curriculum frameworks and assessments as well as comply with statewide education reform requirements. Teachers strongly supported using the standards and the project itself. The standards became a structure for career exploration and development of all students at Tyngsboro High.

A planning committee consisting of the principal, key teachers, administrators, and human services professionals from the local community outlined a process of career exploration. The process included school-based and work-based learning activities that focused on exploring the local human services industry, and would culminate in a community-based project.

Human services skill standards were integrated into the 10th-grade English classes. First, all students participated in a research-based career project in which the communication competency area skills were practiced. Second, a crosswalk was developed that linked the human services skill standards with the state curriculum framework for 10th-grade English. Students developed projects in which they demonstrated both skills identified in the statewide English curriculum framework and communication skills

CASE STUDY CONT'D

embedded in the human services industry.

A common lesson format was developed by teachers to include objectives, classroom activities and procedures, materials to be used, minimum skills to be taught, and evaluation. Teachers identified the following topical outline for five 10th-grade lessons.

Lesson 1: Students explored a variety of careers by researching such questions and topics as, What is human services? What do human services workers do? What are some approaches to a human services endeavor? They developed a list of careers in the human services field, and presented their findings in a research paper. Students utilized in-school resources, the Internet, and a public speaking forum. Time was scheduled for the 10th-grade English classes to use the library for Internet research.

Lesson 2: Students used the Choices Program to investigate education needed, physical demands, temperaments, earnings, aptitude, future outlook, work hours/travel requirements of groups of careers which form the high school pathway. Results of this exploration were presented orally, by poster, or chart or in a written report to the class.

Lesson 3: Students practiced seeking employment for positions of interest by looking for these positions in local newspapers or on the Internet.

Lesson 4: Students selected an occupation (among the human services occupations) and designed a pathway starting in high school to the actual job. Students outlined the education needed, physical demand, temperaments, and future career opportunities.

Lesson 5: Students took the Choice Inventory and participated in a discussion on career pathway and portfolios for career awareness and planning.

Impact on School: Eventually all students at Tyngsboro High School cycled through this career exploration system. All grade 10 students in this pilot had the opportunity to explore human services careers.

The planning committee developed a project work plan which included creating a body of overseers; training teachers in understanding their role in the project; helping students explore the human services industry; requiring all 10th graders to complete a human services project developed around the human services standards, research, English, and frameworks objectives; providing broad instruction in all aspects of the industry as part of work-based learning; developing mentor relationships between human services providers and students with sincere interests in the human services career areas; and granting credit for off campus activities related to the human services project.

3

What Might Be Included in a Curriculum Framework for Skill Standards Integration?

Upon exiting school after grade 12, 14, or 16, all students should be prepared to enter into and succeed in the workforce. To do this effectively, students at the elementary and middle school levels need to develop basic foundation skills and knowledge which employers say have a significant impact on the success of technical and professional workers of the future. These skills can be linked to basic academic skill development at the elementary and middle school levels. They can be learned along the developmental continuum, increasing in complexity and sophistication throughout the K-16 school experience. Such foundation skills can be included in English, reading, science, mathematics, and technology curricula. Examples of such skills are as follows:

- Working within defined parameters such as following protocols, SOPs (Standard Operating Procedures), MSDSs (Materials Safety Data Sheets), ISO (International Standards Organization), and work site and federal requirements;
- Developing a basic understanding of technology concepts such as the interrelationship of systems and subsystems, control systems and limits; processes (design/manufacturing), and simple, mechanical, and computerized machines;
- Engaging in hands-on experiences with process and quality control, the design process, and research and development;
- Understanding, reading, writing, and communicating technical and nontechnical information and concepts;
- Troubleshooting and finding the root cause of a problem, measuring accurately, or using technology as a tool.

Besides the foundation skills found across all industries, each specific industry has fundamental concepts, skills, and knowledge which prevail in that industry setting. These, too, can be included in curriculum at early levels. For example, the body of knowledge and concepts associated with genetics drives much of the research, development, and manufacturing in the bioscience industry. Students can be introduced to these concepts through academic disciplines, projects, and contextual and problem-based learning at the elementary levels. As they move through the middle, high school, and college programs, they should develop an incrementally sophisticated understanding of technical concepts and their applications. They should experience work settings in which these concepts and practices are used, and have hands-on opportunities to simulate and practice skills needed to succeed in these work environments.

Framework for Integrating Industry Skills and Knowledge into English/Language Arts

The following frameworks illustrate ways in which industry skills and knowledge can be integrated into academic and technical disciplines. Examples of activities indicate ways industry skills and knowledge can become authentic learning experiences for students.

Communication is an essential skill of successful workers in business and industry. Future workers need to listen, understand, speak, read, and write to effectively communicate technical and nontechnical information to colleagues, team members, customers, and suppliers, and to manage the flow of communication. A curriculum whose goal is to prepare students for eventual work helps students achieve grade appropriate, basic communication skills; integrates industry terminology at the earliest grade levels; provides a range of reading and communication activities which include opportunities to experience technical and professional communication; and requires students to express themselves in a variety of formats including posters, research papers, speeches (informational, persuasive, etc.), and written and oral group presentations with audiovisual support.

English/Language Arts Framework Examples

Elementary School	Middle School	High School	College
• Communicate in teams • Present one's ideas before the class • Prepare a poster • Write a research paper • Write a protocol or procedure to be followed • Ask guest speakers what they do at work and what they need to write • Become a penpal with someone who works and ask them about what they need to know and be able to do at work • Discuss what it takes (all the jobs and people) to makean end product • Record scientific observations accurately	• Participate in group work, write "shift change" instructions • Find root cause of a problem • Keep a notebook of work place terminology you don't understand • Ask a worker what communication skills they have used to help them solve real problems encountered at work • Experience communicating effectively to other members of a team • Write a SOP • Listen for accuracy	• Analyze films that deal with work concepts (*9–5, Working Girl, Gung Ho, Norma Rae, Matewan)* discuss the culture of work gender differences, and development of unions • Write a research paper on skills needed in an industry • Communicate with a technical/ professional mentor via e-mail • Use technical terminology • Conduct interviews with retired workers • Develop a visual presentation of a project • Write a business plan	• Write technical reports • Make oral presentations related to a project • Use project management software • Develop proposals • Develop audio visual presentations • Prepare technical drawings/ sketches •

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Framework for Integrating Industry Skills and Knowledge Into Reading

Reading and communicating technical information requires precision and attention to detail. Grade-appropriate reading skills, including reading basic technical materials and interpretation of maps, charts, graphs, basic schematics, and technical drawings, contribute to the career development of all students. Reading materials should include technical and scientific works, newspapers, journals, and examples of role models in technical and professional careers.

Reading Framework Examples

Elementary School	Middle School	High School	College
• Follow written directions and simple protocols • Read about people who work • Build a lego simple machine from the picture directions • Identify patterns in groups of pictures • Interpret simple charts and tables	• Read technical and scientific magazines • Read journals of children working in textile mills during the late 1800's—compare these to working conditions now • Read simple manuals for home appliances and program them to work • Read and follow instructions for video games • Interpret emergency evacuation routes from a map	• Read original sources for research papers • Read manuals • Read and interpret schematics, technical drawings, or blueprints • Find the root cause of a problem through a case study presented visually (written, schematics, video, etc.) • Interpret trends from data presented in charts and tables • Read and follow instructions for simple software installations • Read biographies of successful scientists, entrepreneurs, and other leaders in their field	• Follow written SOPs, ISO Standards and protocols accurately • Research technical information via Internet, technical journals, and other technical reports • Read technical journals related to your field • Interpret a specific process control system presented on screen

Framework for Integrating Industry Skills and Knowledge Into Mathematics

Mathematics can be viewed as an essential workplace skill when we consider both the content and the processes found in the study of mathematics. A solid grounding in basic mathematical skills which include the use of fractions, decimals, graphs and basic statistical comparisons, estimation, problem solving (using workplace contexts to encourage informal learning), and the development of mathematical ways of thinking should begin at the elementary level, and should be enriched with real work applications which validate for students the utility of mathematics and the connection of this discipline to future career success. By middle school, students should use mathematics to help analyze control processes (e.g., statistical process control in manufacturing, pilot plants, research facilities, and quality control in all types of work organizations). They should understand the concept of "limits" and begin to make predictions on when something is going out of limits. In high school students should begin learning more sophisticated mathematics associated with a variety of service, professional, and technical careers, and use their mathematics experience as way to prepare for the career of their choice.

Basic measurement skills using measurement tools found in industry whenever possible (e.g., calipers, graduated cylinders, statistical process control, and quality control measurements) are essential skills for success in current and future workplaces in all industry clusters. Learning to use, convert, and record measurements accurately (physical, abstract, and computer-based measurements) should begin in the earliest grades and grow with sophistication and complexity.

Mathematics Framework Examples

Elementary School	Middle School	High School Level	College
• Solve simple mathematics problems found in workplaces • Recognize trends and patterns • Present information in charts and graphs • Measure 25 different objects, record measurements in a log. • Follow a recipe accurately. Bring the resulting substance to school for show and tell • Keep water for fish within its upper and lower temperature limits	• Solve a problem found in a worksite visit using ratios fractions, metric system/ conversions, percentages • Use simple statistics, algebraic equations solving for single variable • Measure a three dimensional object, make a pattern for that object identifying its measurements, recreate the object in paper from the pattern • Measure object (e.g., piece of wood furniture) calculate materials and cost needed to build it	• Measure something accurately to the .0001 using calipers • Create equations which solve specific problems • Create a quality control system and use statistics to monitor it • Develop a financial plan with profit and loss projections • Draw an object to scale	• Create equations to solve theoretical problems • Monitor process control systems, calculating potential impact when components exceed limits

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Framework for Integrating Industry Skills and Knowledge Into Science

Basic science skills, knowledge and processes, and scientific method should include whenever possible the terminology, tools, processes, and procedures found in industry settings. Experiences in following standard operating procedures (SOPs) and protocols, keeping records and scientific laboratory notebooks according to industry guidelines, working in teams and individually to carry out research and experiments, recording observations, and presenting findings in teams and individually all prepare students for future careers in science and technology fields. They should also be provided every opportunity to experiment using both traditional and high technology tools, visit scientific work sites, interact with scientists, and perform useful experiments in partnership with industry mentors throughout their K-16 educational experience.

Science Framework Examples

Elementary School	Middle School	High School	College
• Recreate DNA by threading colored beads on a string • Practice (role play) being a scientist by carrying out an experiment • Read an MSDS (Material Safety Data Sheet) and find out how to keep the tadpolls alive (e.g., water temperature and conditions) • Use scientific and work place terminology (e.g. protocol, MSDS)	• Keep a laboratory notebook to industry standards (e.g., black ink, cross out/don't erase) • Create a diet for yourself, calculate calories, fat, and sugar for one week • Explore scientific work settings, assess what scientists do against your interests • Identify what scientists need to know and be able to do to be successful • Group project: identify and chart 100 jobs that require science knowledge and skills—include job title, one sentence description, education required, average salary, and unique working conditions (e.g., 24 hour call, works outdoors)	• Keep a laboratory notebook to industry standards • Become part of a scientific project within your community where you are mentored or linked to a scientist • Intern at a science laboratory or work setting • Analyze skills standards (Bioscience, Chemical Process, Hazmat, Articultural Biotechnology) needed by people entering science related careers, compare the skills and knowledge in your classe to the skills needed by those workers • Conduct essays and tests	• Design experiments • Assess your skills against standards for bioscience, chemical process and hazmat skill standards • Participate in cooperative learning activities in scientific houses, laboratories • Write papers based on primary sources of scientific inquiry

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Framework for Integrating Industry Skills and Knowledge into Technology Learning

Curriculum designed to prepare people for workplace success builds their capacity to become effective users of technology. Such a curriculum builds on a student's current understanding of technology learned through formal schooling and informal interactions with technology at home and in the community. Recent and rapid changes in technology, and social expectations of students and workers, have redefined what it means to be an effective "user" to include a basic mastery of the more highly technical skills and concepts previously relegated to the technician or technology professional. For example, an effective user can troubleshoot; install software and printer drivers; access a variety of external communications and use the Internet as a tool at work and at home; and can design, develop, and present computer-driven media presentations. Through this curriculum students would develop a basic mastery of technology skills and concepts related to life and work; namely, word processing, databases, charts/graphs, spreadsheets, basic programming; and an ability to use technology tools and measuring and develop an understanding of the concepts that drive the use of technology.

Technology Framework Examples

Elementary School	Middle School	High School Level	College
• Use computer as tool to learn—developing basic software and hardware user competencies (e.g., boot up/shut down machine, access own portfolio), educational software, Internet (e-mail to other students, research on web) and electronic portfolios • Create simple games on the computer with user friendly software • Schedule guest speakers who work in the computer industry to talk about their work • Use lego/logo activities • Build simple and motorized machines with lego/dacta materials	• Keyboarding course • Use computer as tool to present communicate ideas (e.g., charts, graphs, reports, scanning pictures) • Build a greenhouse and program it for temperature control with lego dacta materials • Create a video game using user friendly software • Input and analyze data in a database, present findings • Use presentation software to present project findings • Create materials to put on a website • Access and use electronic portfolio	• Keyboarding lab open for student who did not take keyboarding course • Create a video game • Use spreadsheet database, word processing program, and presentation software to generate a report and present its findings • Maintain your electronic portfolio • Work-based learning using computer tools • Conduct research on the web • Analyze the different jobs in the information technology industry and report on how it has impacted the ways we work	• Use e-mail • Assess skills against IT skill standards • Install software • Troubleshoot minor software and hardware problems • Develop an electronic resume • Participate in on-line courses • Produce research papers which integrate word processing, database, and presentation formats • Conduct an on-line job search

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Framework for Integrating Industry Skills into Career Development

Skills standards can be used to support a developmental process within which students move through phases including

- career awareness in which students learn about themselves and the career opportunities available in the world around them;
- career exploration in which students look at their personal likes, dislikes, values and interests, and begin to actively investigate the career opportunities available, match their own lifestyle preferences with those opportunities, and make preliminary career decisions and plans;
- career preparation in which students actively pursue a career through education, training, mentoring, and workplace experiences;

Career Framework Examples

Elementary School	Middle School	High School	College Level
• Become aware of careers around you, in your family, and in your community • Bring guest speakers in to talk about what they do, and what they need to know to succeed on the job ask them to describe the problems they solve and have students solve one of their problems • Introduce basic foundation skills (e.g. process control, design process, systems thinking)	• Explore your own likes, dislikes, interests, and values • Explore the world of work • Take a career interest inventory to help validate your own career interests • Identify and explore 15 careers • Visit worksites to observe and interview workers learn about problems they have solved using mathematics and science and report on industry skills standards seen in action	• Make preliminary career decisions • Visit worksites—interview workers to determine what they need to know to succeed on the job, what's most challenging about their work, what they expected to find and what they actually found their jobs were all about • Participate in work-based learning in a career field of interest • Develop a career plan which will allow you to become cross trained within an industry—include options and requirements for upward mobility • Include industry skills standards, introduced, practiced, and mastered on resume	• Set goals for mastery of specific industry skills • Develop a resume around skill standards • Participate in cooperative experiences • Use skill standards to help research future work places based on their expectations for workers • Use skill standards to develop questions to ask at your job interview

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- career change in which adult students cycle through this process (awareness, exploration, and preparation) to change careers or upgrade their skills within the same career cluster.

Drawing the Frameworks into Integrated Lessons

It is sometimes difficult to visualize how the elements of these frameworks come together in an integrated lesson, and how they might relate to one another in the development of projects designed to integrate academic and skill standards. Some teachers have had success developing integrated lessons using the format explained in these three steps:

1. Write your project idea in the center box.
2. In the column to the left, list the academic knowledge and skills that will be the primary focus of the integrated project and assessed as the project is carried out.
3. In the column to the right, list the skill standards or technical skills and knowledge which will be the focus of this project and will be assessed as the project is carried out. The boxes indicate where the technical skills will be developed, practiced, or mastered and which teacher has responsibilities for assessing the student's progress on that standard.

The completed form provides the teaching team a picture of the academic and skill standard components that are integrated in the project, and clarifies which team member has responsibility for assessing student progress on that standard.

Conclusion

Although challenging, developing standards-based curriculum is not an insurmountable task. There are many rich and clear examples to be shared and adapted. Skill standards-based curriculum that integrates academic and technical learning sets forth the high and real demands of industry, clarifying expectations for learner performance and increasing options by demanding both academic and technical competence. Providing rich content, context, and meaning to the learning process, an integrated curriculum reflects the reality of the workplace where learners

- deepen their academic content and technical skills;
- develop employability skills and practice the informal learning patterns found in today's workplaces;
- build their capacity to solve complex problems that characterize life and work.

In this chapter we have presented a variety of ways schools, education systems, and other organizations use models, frameworks, tools, and strategies to structure curricula that prepare learners for workplace success. These examples show how skill standards can be used to explore occupations and career paths helping learners see more clearly the "connections" between what is learned in school and what is practiced and refined at work. They present a curriculum framework illustrating how technical vocabulary, concepts, and skills can be drawn back into the K–16 curriculum and linked to academics opening new doors of opportunity and access to the world of work.

Creating Instructional Strategies for Standards-Based Programs

Teachers preparing people for workplace success need to have a full and varied repertoire of instructional strategies which

- motivate and support learners as they develop skills and knowledge needed for success;
- meet the needs of learners with varied learning styles and preferences;
- are geared to high standards for all students;
- promote rigorous academic and technical learning, as well as SCANS/employability skills development;
- provide hands-on experiential learning that mirrors real work;
- are useful in school-based and work-based learning and connecting activities.

Each of the three parts of this section includes examples of preparing people for workplace success:

- The first provides a broad overview of the many instructional strategies found in these programs;
- The second and third take a deeper look into the two major instructional approaches found in many of the examples we studied: competency-based learning and contextual learning.

Competency-based learning (CBL) is used by many technical education and training programs to focus learners on developing specific technical skills and knowledge, and mastering specific tasks related to future careers. Competency-based programs put the student at the center of learning with clear expectations that they take an active role in the learning process. This methodology is characterized by precise task- or skill-focused learning activities, record keeping strategies, and assessments. Learners are presented with a skill to master or piece of knowledge to learn, and are led through prescribed steps to achieve that goal. Learners take responsibility for learning by seeking specific resources to help them acquire new knowledge and skills. Competency-based learning is based on clearly defined performance standards. These skills and knowledge sets are precisely measured, recorded, and listed in a competency report, which a student might include in his or her résumé.

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Contextualized learning, although less regimented than CBL, also asks the learner to take an active role in the learning process. Strategies supporting contextual learning include

- solving of real world/work problems;
- connecting learning to its applications in life and work;
- continuous learning;
- ongoing assessment;
- special emphasis on development of higher-order thinking skills (e.g., analysis, synthesis).

This section discusses problem-based learning, a popular strategy which uses the workplace as a context for learning and asks learners to solve problems commonly faced by front line workers.

Although examples of a variety of instructional strategies are presented, elements of both competency-based learning and contextualized learning were found in many programs designed to prepare students for school-to-career success.

The key to standards-based instructional strategies, which effectively prepare people to succeed in rapidly changing, highly technical workplaces, may lie in the deliberate integration of competency-based learning and contextual learning methodologies.

Key Questions

1. What instructional strategies are commonly used to prepare people for career success?
2. What instructional strategies are used to support the mastery of tasks and development of competencies?
3. What instructional strategies are used to support contextualized learning in programs to prepare people for success in the new workplace?

1 What Instructional Strategies Are Commonly Used to Prepare People for Career Success?

Using skill standards-based instructional strategies requires learning new teaching or learning methods which may not be in the repertoire of traditionally educated teachers.

The following examples illustrate instructional strategies often found in academic and technical programs that prepare people for workplace success. Part I lists many strategies used in

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workplace preparation. Part II lists some of the new ways of learning in programs on the cutting edge.

How Skill Standards Can Help

Skill standards provide rich content and structure to support a variety of instructional strategies that teachers can use in their classrooms and shops. The duties, tasks, skills, and knowledge identified in most skill-standards job analyses provide a solid structure that fits easily and comfortably into the competency-based methodology used in many technical/vocational and training environments.

The scenarios or work-based problems associated with many skill standards capture the ways workers integrate their skills and knowledge in the workplace to perform routine work and solve problems that arise on the job.

Scenarios are also used in problem-based, contextualized learning now found in many academic settings. Skill standards offer the opportunity to draw from the best of both of these methodologies to deliver a curriculum that is deep in content, substantive in process, and integrated across academic and technical disciplines.

Teachers can use skill standards to connect the knowledge and skills learned in school with the work performed in workplaces. Teams of teachers and workplace supervisors can identify and develop activities from an agreed-upon list of required skills and competencies. Both can record and assess student progress toward agreed-upon goals. Instructors from secondary and postsecondary schools can work together to identify competencies and develop curriculum and activities for each education level, and link learning to industry needs. Teachers can use skill standards to guide students in internships, cooperative learning experiences, and other work-based learning.

Part I: Staples of Career Preparation

Strategies to Promote Interdisciplinary Work and Learning

Common Planning Time: Designated time is set aside for teachers to plan together within or across disciplines and/or grade levels. Common planning time is usually found in programs implementing interdisciplinary learning, project-based learning, and team teaching. This time can be useful for teachers periodically to assess how individuals and groups of students are progressing in their acquisition of skills and knowledge identified in the skill standards. Common planning time for students is also an effective technique when regrouping to work on large-scale, cross-class, or cross-grade projects.

Interdisciplinary Learning: Students and teachers work together across disciplines on an activity, theme, or idea to enrich approaches to a common topic and to develop the connections among disciplines and skill areas. Skill standards can help keep the learning focused on specific skills and knowledge goals.

Team Teaching: Teams of two or more individuals teach students at the same time, sharing responsibility for helping students develop skills and knowledge and evaluating student progress. Common teams include teachers from the same discipline, teachers from different disciplines, teachers who teach different grade levels, academic and technical/vocational teachers, frontline workers and teachers and counselors and teachers.

Themes: Topics (big ideas) are the center around which learning revolves; for example, high-performance workplace skills, skill standards, the culture of work, the global marketplace, transitions from manufacturing-based economy to an information-based and economy, mathematical ways of thinking. Sometimes schools choose themes for different months, with each teachers relating a portion of instruction to the theme. Themes provide a venue for integrating learning across disciplines and grade levels and between school and work-based learning.

Learning First-hand about Workplace and Careers

Field Trips: Groups of students visit work sites or businesses to see occupations in action and gather information. They learn firsthand what workers need to know and be able to do to succeed on the job, and the types of problems workers are asked to solve on a regular basis. Field trips allow students to see one career in depth or observe the variety of jobs in a business setting. Field trips also allow students to walk through a business from beginning to end, and to begin developing a sense of how a company is a system and how the different departments operate as subsystems within a larger system. This exposure helps students see how the work of individual workers in one part of a company impacts the work of others and the company as a whole. Field trips are common strategies for career awareness and exploration stages.

Guest Speakers: Professional, technical, and service workers are invited to school to share their work experiences with students who are exploring career options or preparing for specific careers. Guest speakers discuss their work, the career ladders leading to their current positions, the academic and technical skills necessary, and common problems encountered on the job. Using skill standards to help frame questions or the discussion helps students make connections between what is learned in school and what is needed for work.

Internships: Students work (usually without pay) at a real job in a local business/industry setting for a specific length of time (one week to several months). In an internship setting students practice core and specialized skills found in skill standards and experience what it is like to work in those jobs. Internships are usually supervised by teachers through site visits or frequent communication with the student's direct supervisor. Students gain academic credits for internship experiences.

Intergenerational Programs: Students interview grandparents and/or senior citizens in the community regarding their life and their work. Students can use this oral history to write about the evolution of industries in their communities, and the economic and social factors that affect career decisions.

Interviews: Students interview workers, relatives, and friends to gather information about a specific topic or project. Besides asking people about the skills and knowledge needed for success, interviews are useful to help students learn about the informal learning that takes place on the job. They discover how people learn from and teach one another, what is acceptable and not acceptable in certain types of work sites, and what people need to know and be able to do to succeed at work.

Mentorships: Mentors are people who guide students through the world of work in various ways. Work site mentors instruct students about their jobs and provide guidance for acquiring and mastering skills. Mentors develop long-term relationships with students providing advice, direction, and assistance in solving problems. Mentors can help students focus their learning on the skills and knowledge needed for career success.

School-Based Enterprises: Students explore what it takes to develop and run a business by operating mini-businesses within schools. When skill standards are included in the instructional framework for enterprises, these activities allow students to develop core skills needed for running a business as well as the technical skills required of that business specialty, for example, food service, catering, construction, manufacturing, or banking.

Shadowing: Students explore careers by spending a specific amount of time (usually a day) observing workers in action and identifying what academic, technical, and employability skills are needed for success in that job. Shadowing can be strong "connecting activities" when students use the experience to identify what mathematics, science, or technical skills the worker used during the day and what types of problems were being solved.

Work Experience: Experiences are gained from the time students spend at work sites engaged in work activities. They include paid and unpaid internships, part-time work during the school year, and full-time work after completing school.

Learning and Working in Groups

Brainstorming: This technique is used to develop lists of items without a great deal of discussion. Within a specified amount of time, participants voice ideas, concerns, items, issues, and solutions without discussion and with an understanding that everyone's contribution has equal value. This technique helps participants open their minds to thinking without presupposed boundaries. Brainstorming is useful in drawing information from students engaged in problem-based learning as they respond to the questions, What do I need to know and be able to do to solve this problem? Who or What are my resources?

Networking: Students draw upon their network of friends, acquaintances, and relatives to learn new things and help make connections related to school and work.

Peer Coaching: Common in problem-based and project learning, students teach, coach, and support each other during class or shop, and work as they acquire knowledge and develop skills.

Peer Support Groups: Students meet in groups to provide support and guidance to each other as they face new experiences and challenges. Peer support groups were found in schools encouraging and supporting students to join and remain in programs which were nontraditional for their gender or culture. Skill standards can help students focus on the skills and knowledge needed for success in school and work environments, and take pride in their accomplishments.

Role Playing: Students act out situations taking on predetermined roles. Role playing allows students to be creative, express individuality, and communicate in a problem-solving context as they place themselves in the role of another person. Frequently the teacher guides the process by initiating ideas, setting the limits, and guiding participants and spectators toward particular objectives. Role playing can reinforce skill standards by asking students to identify the skills and knowledge required or demonstrated in the role-play situation.

Other

Bulletin Boards: Bulletin boards can help students and teachers learn about recent changes in industry, see pictures of what high-performance industry work sites look like, visualize cell structures, see graphics of work stations used by cross-trained teams, and see the "systems" characteristic of modern business displayed. Bulletin boards can also exhibit students' projects, self-directed research studies, connected activities products, or work-based learning experiences through photographs, reports, schematics, charts, and graphs. A skills-focused bulletin board will help students make connections between school and work.

Distance Learning: This technique is used to carry out teaching and learning across distances. For example, it is used in rural areas where students may not have access to teachers with the skills and knowledge they want to develop. Distance learning allows students and teachers to work through course materials via radio, or one- and two-way video.

Part II: New Ways of Learning

Using Technology Tools in Learning and Working

Asynchronous Learning: This learning takes place without a specific time structure, as in online and web-based learning where individual learners within a group can log on at their convenience. (*See New Hampshire Technical College Bioscience example.*)

Authors Online: Noted specialists in the field are available online for short time periods (one week to one month) to answer questions about an article or book they have written and research they have conducted, or to facilitate a discussion on their content specialty. When an article, book, or report is published an announcement specifies the author's availability to discuss the topics and issues he or she has written about.

Learning Laboratories: Such laboratories serve groups of teachers and students within specific geographic regions, and provide hands-on experiential learning opportunities using equipment found in industry and following industry standards and protocols. Students and teachers are scheduled into the laboratory for short-term learning experiences.

Online Courses: Credit and noncredit courses are offered online for a specified amount of time, usually consisting of sets of lectures, readings, problems, and activities.

Use of the Internet: Students and teachers find answers to questions, seek information, and communicate with peers and/or professional and technical workers engaged in research and special projects.

Virtual Workplaces: Virtual workplaces are on-the-job training experiments which take place in school settings. Students prepare for the transition to work by working and behaving as a professional.

Strategies That Promote Problem-Based and Contextual Learning

Guiding Questions: With this technique teachers guide learning by asking questions. Guiding questions are designed to draw targeted information from learners. This strategy, found in problem-based learning lessons, is used to keep the learning focused on intended skills and knowledge acquisition while minimizing prescriptive learning.

Learning Occupation: An invented occupation combines all the core tasks, skills, knowledge, and behaviors required for successful performance in a range of related occupations in an industry. Learning occupations can help frame the learning boundaries for students involved in career magnets and occupational clusters.

Problem Scenario: An authentic, real-life/work situation places skills and knowledge in the context where mastery of routine performance must be demonstrated and a problem must be solved. Workplace/skill-standards scenarios illustrate the problems workers are expected to be able to solve. Assessment scenarios are used to evaluate the progress of students or incumbent workers. Instructional scenarios are used to help students learn and develop skills. Application scenarios provide examples that apply academic learning at work.

Problem-Based Learning: Students develop knowledge and skills as they define problems to solve, identify criteria to recognize good solutions, research what they need to know and be able to do to solve the problem, and pose possible solutions. Students reflect on their solutions and recommend what they would do differently if they were to solve the problem again.

Project Learning: Students develop skills and knowledge as they plan and carry out projects that integrate academic and technical learning in schools and communities. Project learning is popular in vocational/technical schools as a way to learn about all aspects of an occupation.

Self-Directed Work Teams: Given an assignment or work order, student teams plan and carry out their work, each taking a variety of roles within the process. When self-directed work teams are used in skills training, students work in teams for the entire time but are evaluated individually on the specific technical skill standards they are required to master within a technical training program.

Simulations: By taking on the responsibilities of real workers, students work through a specified set of activities that replicate the tasks in real-work situations. Simulations can be presented as in-basket activities, paper-pencil activities, problems, projects, and equipment-based or computer-based learning activities. Computer simulations refer to activities that rely on computers to provide a virtual environment and venue to accomplish the tasks without having to be in dangerous situations or use expensive equipment or supplies to develop technical skills. Simulations are used on the job, for purposes of training new workers, when production lines cannot be slowed or stopped. Simulations designed around integrated skill standards provide students hands-on experiential learning that mirrors the ways skills and knowledge are used on the job.

The following examples and case studies illustrate the ways programs preparing people for workplace success have used the instructional techniques listed.

City University of New York (CUNY) - *instructors using human services skill standards*

Instructors implementing the human services skill standards at CUNY made use of the real-life work experience of students and practitioners and, whenever possible, the experiences of consumers, by using actual case studies or scenarios. Instructors also used authentic instructional resources including newspaper and journal articles, videos and films, and case notes (when available). They found the following instructional methods particularly effective:

- Role-playing interactions between human services consumers and care-givers;
- Class visits by consumers and family members to talk about their experiences with human services provision;
- Field visits to a variety of programs, settings, and consumer group meetings to observe and document real-life situations;
- Students writing or describing case studies/scenarios based on their own work experiences as direct care providers, and using these for class discussion;
- Students writing mock letters to the editor, taking a stand on a current controversial social policy issue;
- Students interviewing colleagues or other human services care providers about their work and the issues affecting them;
- Students examining the skill standards and their components (tasks, skills, knowledge, and work activities) to identify those they performed or used as part of their work or work-placement experience.

Foothill College, California - *using the case study approach, bioscience skill standards, and related academic skills to create innovative instructional materials for high schools, community colleges, universities, and industry*

Foothill College, near San Francisco, received a grant from the National Science Foundation, Advanced Technological Education Program, to develop a series of case studies to be used as teaching materials in the field of bioscience. The case studies are being developed with active industry participation, and will include hands-on laboratory components. They focus on promoting student understanding of the workplace skills needed to function efficiently, effectively, and safely in entry-level biotechnology careers. The cases provide a forum for problem-based learning, in which students discuss the issues and dilemmas presented and ways to solve them. In this way, students will be prepared for similar real-life situations in the workplace.

The first case study was tested in a workshop during the summer of 1998 with a group of teachers. The workshop included introduction to the case-study teaching approach, an introduction to and discussion of the cases, and a hands-on lab model. Participants also reviewed the Facilitators' Guide, prepared as part of the project, and received detailed coaching on using the case study teaching method and the guide. Workshop facilitators also provided ideas about how to incorporate the case into exisiting curriculum and how to develop personalized lesson plans to fit a variety of teaching situations and needs. Video-conferencing techniques were presented and ready-to-use lab kits were distributed. The workshop was considered a pilot test, and teachers were asked to evaluate the materials and presentation, identify any difficulities, and help resolve them.

"An Ultra Bad Hair Day," developed in partnership with Stratagene, is one example of their case studies. In this scenario, a product coordinator at the fictitious "Ecco Hair Design" discovers that there may be a serious problem with one of the company's products. The product coordinator must work along with the Quality Control team to uncover the root of this potential disaster. The conceptual focus of this case and lab is protein purification. Lab exercises introduce students to protein separation using both size and charge differences of proteins. Students must follow Standard Operating Procedures (SOPs) and may also choose to design a revised SOP as a post-lab activity. *(See exhibit 5A.)*

There are currently four case studies available in various testing stages. After pilot testing, teachers have incorporated the case studies into their curriculum. Evaluation then follows on the use of the case studies and their effectiveness. By August 2000, there will be a total of six case studies completed.

This project is an excellent example of how teachers can use real-work scenarios for teaching technical, academic, and employability skills (teamwork, problem solving, decision making). It is also a very good example of how to involve people from industry in the education process.

Middlesex Community College and MiraCosta College - *using industry skill standards to develop résumés and interview responses*

One of the most commonly used methods to prepare students for the transition to work is the résumé and job interview. In Middlesex Community College's biotechnology seminar, students increase their awareness of which skills are used in a specific work setting. Students are given the EDC/FAA industry skill standards for Bioscience/Agricultural Biotechnology at the beginning of the semester to assess their abilities and record their progress in the lab-based courses. They use this list to develop their résumés. At MiraCosta College, students in the biotech seminar class develop résumés that focus on their laboratory skills. Local business partners invite students into their biotech companies to practice their job interview skills with industry recruiters. They receive immediate feedback on their performance. Students then share their experiences with the entire class in facilitated debriefing sessions.

Strategies That "Mirror Today's Workplaces"

The following examples illustrate simple ways that some teachers have changed their teaching methods to mirror today's workplaces:

Constructivist classrooms mirror high-performance workplaces. When compiling research, EDC and other researchers found striking similarities between the characteristics of high-performance workplaces and constructivist classrooms. These similarities suggest that

- inquiry-based, constructivist learning strategies have value in the preparation of future technical and professional workers;

Exhibit 5A: CIPB Case Study #1: "An Ultra Bad Hair Day"

Workplace Skills	Case Material	Related Academic Skills
Follow Protocol Keep Accurate Records. Comprehend a technical vocabulary.	Lab written as SOP*. Case covers protein purification using column chromatography and analysis of materials on polyacrylamide gel electrophoresis.	Understand and apply Scientific Method. Describe and explain acids and bases in general, including their relation to pH and
Safety Keep work area free from clutter. Use appropriate safety procedures and guidelines. Monitor, use, store, and dispose of hazardous materials properly. Use protective equipment.	Lab written as SOP & students directed to organize and clean area before beginning procedure. Use and wear appropriate safety equipment and personal protective equipment as needed in kit.	Understanding amino acid chemistry and protein structure and characteristics. Written communication and comprehension skills, and oral skills.
Basic Lab Skills Prepare glassware. Make stock reagents and solutions. Monitor physical properties of a solution. Maintain reagent integrity. Use basic weighing and measuring techniques. Perform basic separation techniques.	Lab directs students to locate all equipment and supplies: Note manufacturer, lot numbers and expiration dates. Students prepare all reagents, including weighing, hydrating and adjusting pH of buffer solution. Lab introduces protein separation using both size and charge differences of protein.	
Quality Control Document product specifications. Perform statistical and data analysis. Compare results to government and/or company standards.	Case materials involves a breakdown in Quality Control.	
Protein Techniques Detect specific proteins. Separate proteins, isolate or characterize proteins. Perform gel electrophoresis.	Students use column chromatography and SDS-PAGE to purify and identify proteins.	
Regulatory Compliance Perform research using Good Laboratory Practices (GLPs) and Good Manufacturing Practices (GMP)	QC problems posed in case necessitates following and updating SOPs written according to GMP	

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* Standard Operating Procedures

Foothill College, California, 1998

- elementary teachers have a role in developing core skills required for success at work;
- the success of students in constructivist learning environments may be related to their future success in high performance workplaces.

Similarities Between High Performance Workplaces and Constructivist Classrooms

High Performance Workplaces	Constructivist Classrooms
• Workers work in teams/cell structures	• Students primarily work in groups
• Worker teams have team leaders, middle management is eliminated	• Students working in teams with teachers as coach/mentor
• Teams produce whole products	• Emphasis on big concepts
• Workers solve problems, questioning process and products	• Student questions are highly valued
• Workers help set policy, mission, rules, production goals, and propose equipment and training investments	• Students organize their own work sequence and pace to meet goals
• Workers are cross-trained to do all team member tasks	• Students have opportunities to rotate through a variety of roles on a team

Abraham Lincoln High School in San Francisco, California

Running a successful biotechnology "company"

At Abraham Lincoln High School in San Francisco, California, students in the Principles of Biotechnology course run their own biotechnology "company." The goals of the company are to provide goods and services to satisfied customers, reward happy employees, be socially responsible, and return a profit to investors and employees. The success of each student is measured on quality of work produced, academic achievements attained, and ability for all members of the company to be successful. Successful implies that each student can achieve and maintain the responsibilities of their company role and attain prosperous group interactions.

Each company includes six positions. The students are split into groups, and volunteer for the positions that are available in the company. Each company consists of the following:

1. *Chief Executive Officer* (CEO), who is the president and appoints all other company officers. Responsibilities include keeping the group focused, distributing team bonus points to members, resolving

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disputes, organizing study sessions, suspending members for lack of effort or poor attendance, and acting as liaison between the teacher and other companies

2. *Chief Financial Officer* (CFO), who tracks the accuracy of each member's grades and bonus points, collects all team grading sheets with assignments, and delivers them to the teacher at the end of each grade period
3. *Research Scientist*, who makes sure assignments are completed, arranges study sessions with the CEO, tutors team members, and assigns team members to review other company's lab reports for submission to the class journal
4. *Research Assistant*, who maintains lab stations, reports missing or broken lab items, erases blackboards, and makes sure all chairs are pushed in at the end of class and desks are graffiti-free
5. *Secretary*, who takes attendance, acts as attendance monitor on a rotating basis with other secretaries, collects team homework to give to the teacher, and produces copies of handouts for absent team members
6. *Floater*, who covers for research assistant and secretary when either is absent, checks team portfolios weekly for completeness, and helps other team officers as the need arises

Each team member must

- publish at least ten lab reports in the class journal;
- maintain his or her own personal portfolio;
- help maintain the company portfolio and prospectus, which contains group examples and student "best examples" of individually graded projects.

The grading works on a bonus point system. Each position in the company achieves a certain amount of bonus points, as well as 12 extra bonus points for any team in which all six members achieve at least a B average on an exam. If all team members receive an A, 24 points are awarded.

The biotechnology company setup is a great method for facilitating student learning. Students begin to get a sense of company life, are actively engaged in company positions/roles, and are held accountable for their duties within the company. It is a good first step for acquainting students with the company structure and operations.

BBEI program with Berkeley and Fremont High Schools - *reinforcing workplace behaviors in classrooms*

Students in the BBEI program at Berkeley and Fremont High Schools are expected to demonstrate workplace readiness such as being on-time and maintaining perfect attendance.

The program reinforces these skills by teaching students time management and requiring them to maintain a personal planner. Students receive "rewards" (e.g., movie tickets, McDonalds coupons) for excellent attendance records. BBEI teachers also create a school-based learning environment that reflects the workplace. Students and teachers rely on observation, inquiry, and discussion, and rarely use textbooks. Perhaps most significant, students are given multiple opportunities to obtain the correct answer. This approach is typical of the workplace, where employees work on a problem until they solve it.

Project SMART - *using the Work-Based Learning Program to develop self-directed learning in students*

Project SMART's Work-Based Learning (WBL) Program encourages students to become self-reliant learners, thinkers, and problem solvers as well as skilled entry-level workers. The goals of SMART's work-based learning are to help students explore many departments in the manufacturing work environment, develop some of the basic technical skills needed to work in each department, and understand how each department fits into the overall organization of the company. Therefore, along with working on specific industry tasks, students participating in the first round of work-based learning are responsible for answering the following major research question: How can this company be seen as a system, and how can each department be viewed as a subsystem within the company?

To help students develop an answer, prior to entering each department they are given a Work-Based Learning Self-Directed Activities Chart with eight questions. (*See exhibit 5B.*) The two-page chart helps students research the topic and organize their work-based learning report. Students find answers to some of these questions by talking with workers, reading or viewing on-site resources, and/or observing demonstrations. Department supervisors help students identify other resources that might provide answers to the questions. Students are asked to review the completed charts with each department supervisor before moving on to their next WBL assignments. Students use the five completed charts to develope their work-based learning report.

Bay Area Biotechnology Education Consortium (BABEC) - *using CU-See-Me,™ to link students and practicing scientists*

The Bay Area Biotechnology Education Consortium (BABEC) found a way for small biotech companies with few resources to enable employees to become involved with education programs, even if the companies are unable to provide internships or release time. BABEC created a solution using distance learning. The organization installs portable laptop computers with video-conferencing capabilities in classrooms and at workplaces. Teachers pose problems to students who can then interact in real time with scientists about techniques in their workplaces. Working scientists can engage with students and teachers without having to leave their work site. Positive experiences from these exchanges may even lead to companies becoming more amenable to having student interns.

[CU-See-Me™ is a product developed by White Pine Corporation.]

Exhibit 5B: Project SMART: Work-Based Learning Program

SELF-DIRECTED ACTIVITIES CHART

Department name ____

How can this company be seen as a system, and how can this department be viewed as a subsystem within the company?

QUESTIONS	ANSWERS	RESOURCES
1. What is the name of this department and what is its function?		
2. What is the role this department plays within the company?		
3. What are the processes that make up the "system" in this department?		

(continued exhibit 5B)

QUESTIONS	ANSWERS	RESOURCES
4. What is the function and purpose of each of these processes?		
5. What technologies are being applied by the system? Which processes are being used?		
6. What rules and guidelines do the processes follow?		
7. Which terms describe these rules and what does each term mean?		
8. What equipment is used in this department? What skills are needed to operate the equipment?		

Questions are taken from Leittexte Approach by BIBB, Germany

San Diego City College/Center for Applied Competitive Technologies (CACT) - *documenting work and protocols using lab notebooks*

Industry-based instructors at San Diego City University introduce students to actual protocols used in industry laboratories. Although these protocols are simplified for students and any proprietary information is deleted, students gain firsthand experience with actual workplace practices, materials, equipment, documentation, and safety practices. Employers donate the "wet" materials, plastics, glassware, and soon-to-expire biologicals that these protocols require. Besides using actual Standard Operating Procedures, students learn to use the same reference materials that employees rely on—company catalogs; textbooks are rarely used. Students in the Biotechnology Instrumentation Capstone course must maintain an industrial-style laboratory notebook, and are required to submit a 3- to 6-page analysis of each protocol. Both of these requirements are designed to initiate students into the work life of professional science.

New Hampshire Community Technical College - *demonstrating new ways of working and learning*

The biotechnology program at New Hampshire Community Technical College in Portsmouth, New Hampshire, focuses on teaching students the lab skills that reinforce what occurs in the workplace. All labs require students to be able to identify protocols, the materials needed, the lab skills used, and the safety precautions required. Students maintain all this information in their lab notebook. Every student learns to operate, calibrate, and troubleshoot the equipment in their lab. Each student masters a particular piece of equipment and some specific protocols, and then assumes responsibility for training all the other students in its use. Teachers in this program believe that this emphasis on the process reinforces the learning of concepts. The process incudes the following:

- Multiple approaches to instruction simulating the workplace in the classroom—virtual labs, hands-on labs, simulated businesses, speakers/representatives;
- Spiraling skills and content to ensure that they are revisited in multiple experiences (e.g., molar solution taught in the beginning of the course can be revisited when preparing buffers for electrophoresis, used in enzyme digestions, proteins purification and isolation, tissue culture).

Human Services Research Institute, Inc. (HSRI) and Education Development Center, Inc. (EDC) - *creating instructional activities related to the human services for elementary and middle school students based on industry skill standards*

The structure and organization of the standards, and the clear definition of skills and knowledge, opens the door to a wide range of real-work applications and interesting contexts to learn important basic skills. These types of contextualization position the standards as an important vehicle to enrich and strengthen existing curriculum rather than becoming an "add on" to teachers' already full set of responsibilities. The following activities illustrate how the human services skill standards can be used to create activities around the medical/health knowledge domain of geriatrics, contained in the industry-related knowledge in Appendix D of the human services skill standards:

In *second or third grade,* students could begin to learn about generations and intergenerational issues in their social studies units by talking about their own families. They could share stories about their own grandparents, great grandparents, or other older people in their lives, and consider questions such as, What is special about your grandmother? Does your great-grandfather need any special help (e.g., he needs help walking down the stairs, or he can't hear very well)? They could consider the roles of the different generations in their families (e.g., they go to school; their parents work; their grandparents work, or stay home to take care of the house, cook, or garden). The students could visit some community agencies, such as senior citizen centers or supported living settings, and talk with older people about what they do and how they like where they are living.

In *fourth or fifth grade,* students could consider in social studies what special needs the elderly have, and how families and/or their communities help or could help. They could discuss or write about how the elderly get help with health care (from hospitals, clinics, visiting nurses), senior center services, discount admissions, transportation, etc. They could relate this to particular people they know, or consider the topic from a community service perspective (e.g., What should a community do to assist older people to live full lives?).

In *middle-school grades,* students could visit various community service centers for the elderly and interview them, using questions they have developed based on discussion about how older people live and particular issues that they and their community support providers deal with. Students may choose to take a photographic or video study of an elderly person they know or a person at a local senior center. They may interview a care provider about systemic problems in elder care. These activities could be done by a group or structured as a project.

EXAMPLE

Southern High School - *keeping up on current industry news*

Students in the Bioscience Academy at Southern High School in Baltimore, Maryland, read copies of industry employers' newsletters. These help students develop the technical vocabulary important in their careers. In addition, students gain a deeper understanding about the issues and key players in the industry. Even more important, students feel that they are part of a professional group and a dynamic industry.

EXAMPLE

University of Maryland School of Medicine, Department of Medical and Research Technology - *following the stock market*

In the Department of Medical and Research Technology at the University of Maryland School of Medicine, students track and analyze the stock of selected bioscience and medical research companies, and give a presentation to the rest of their class about their chosen company. This helps all of the students develop a feel for what and how well individual companies are doing, as well as industry trends and issues.

2

What Instructional Strategies Are Used to Support the Mastery of Tasks and the Development of Competencies?

Many educators use a task mastery approach to prepare learners for technical and vocational occupations with a competency-based curriculum. Our studies have found that task mastery and competency development open doors to employment. Their related instructional methods are considered to be critical elements in programs preparing people for work.

Since the early 1970s competency-based vocational education (CBVE) has been designed specifically to prepare people for direct entry into the world of work. This methodology began as a way to focus vocational training curriculum and instruction on the skills and knowledge needed by workers in specific occupations in the communities surrounding their schools. It always includes development or validation of the program task lists with local employers.

The CBVE system organizes instruction around learning modules, which students can work through independently or in groups. Therefore, its instructional methodologies differ dramatically from those of the large group lecture/demonstration found in traditional vocational training programs. In a CBVE environment students can move from one learning guide to another, at different rates while they master tasks. This requires the teacher to become a manager of instruction. Sophisticated instructional management systems need to be in place to ensure that students are supported through the learning process, provided with feedback and tested when ready.

Rather than a narrow, specific task-training focus, CBVE encourages interdisciplinary instruction, integrated curriculum, teamwork among students, and project-based learning which mirrors settings sometimes called "high-performance workplaces." Many CBVE programs are open-entry, open-exit. This allows students to enter at any time and test out programs without having to put in extensive class time relearning previously developed knowledge and skills. Student records are passed from one grade-level teacher to the next and maintained in ways to track continuous learning and skills/knowledge development. Competency lists are frequently maintained by many teachers and move with students from grade to grade as they progress through a program. Capstone projects are organized to help students demonstrate expected levels of mastery at the end of formal programs. This type of CBVE system has significant impact on the teaching/learning environments. It requires teachers to use a wide range of instructional strategies to accomplish both program and individual student learning goals.

Many schools still adhere to the tightly prescribed CBVE processes; others have taken key elements of the CBVE system (e.g., performance-based assessments, record-keeping strategies) and integrated those into their education and training programs.

How Skill Standards Can Help

Local adaptations of national skill standards can replace task lists geared only to that locale. This will help students develop the skills, knowledge, and attributes recognized nationally and geographically. Competencies based on the standards can ensure that the curriculum includes mastery of the tasks, skills, knowledge, and attributes defined by the skill standards. Learning activities and resources related to the standards and their competencies can be used for both school-based and work-based learning. Desired learner outcomes can be used to develop performance and knowledge tests and projects to assess student mastery.

New Hampshire Community Technical College System

Students study and work in The Virtual Workplace

Within the New Hampshire Community Technical College System, four 2-year college programs have redesigned their curricula to focus on learning the skill of the national industry skill standards, as well as knowledge and behavioral attributes which relate to their field. The four programs are electronic systems engineering technology, biotechnology, advanced automotive technology, and human services. These changes in the expected outcomes of the programs have created changes in pedagogy, structural changes in the delivery of programs, and the length of classes. Basing courses on the skill standards, with their emphases on real-life uses, has opened up instructors' thinking to a wider variety of instructional methods and new ways of working with information. This includes working across disciplines with their colleagues to integrate subject matter, as it is in real work situations.

The automotive technology program at Laconia Technical College prepares learners to be automotive repair technicians. It is certified by the National Automotive Technicians Education Foundation (NATEF) and a General Motors Automotive Service Education Program. This program has adopted a competency-based methodology, with staff designing competency-based student materials as well as record-keeping and progress-reporting systems. The competency-based system facilitates the integration of NATEF standards, the requirements of GM training, and the course requirements for graduation from the New Hampshire Community Technical College System.

Changes in instructional methods had an impact on all aspects of the teaching/learning environment. The emphasis on re-creating real work situations has led to the creation of *The Virtual Workplace* in each of the programs. (*See exhibit 5C.*) Classrooms are configured to operate as real workplaces. For example, in the virtual electronics company called ESETCo (Electronic Systems Engineering Technology Curriculum Organization), students do not enroll in the course; they apply for a position in "the company" by submitting a cover letter and résumé. Also, student projects are designed with real "customers," to meet practical needs, rather than as academic exercises culled from a textbook. The company incorporates standards of practice outlined in ISO9001, the international quality management and assurance standards of practice for a high-performance, quality-driven workforce. Students are expected to learn in a hands-on

Exhibit 5C: A Pedagogy Blueprint For The 21^{st} Century

Once each student crosses the threshold into The Virtual Workplace they are immediately transformed into an employee of a virtual business. The first day on the job, skill standards and general expectations are clearly articulated by the instructor-employer. The student-employee quickly learns this unique educational environment is a "hands-on" learning experience where information is not obtained from a lecturing instructor nor from cookbook lab experiments. Instead, students, organized into teams, are working with team members collecting, interpreting, analyzing and evaluating data for the purpose of problem solving. Individual student-employees are held accountable for performing each task competently and for eventual mastery of skill standards. Meanwhile the instructor oversees the operation of The Virtual Workplace through the preparation of lessons and lab assignments, using the skill standards for their occupational area as the focal point.

From this vantage place one can see the 21st century classroom. Yet, one can also see back to the future. For all its outward sophisticated employment of high tech equipment, The Virtual Workplace is a throwback to the Middle Ages' world of apprenticeships. The major difference between these two worlds is the specifically prescribed written performance skill standards from which the program, the course content, methodology, and student assessment flow.

Like the apprentice in the Middle Ages, students learning in The Virtual Workplace experience an on-the-job training program that fully prepares them to easily move into a job in the real workplace. Upon entering The Virtual Workplace the student becomes a professional who works and behaves as a professional. Each student-employee is evaluated using the same skill standards as industry. The student-employee must demonstrate a required level of competency and mastery of each skill. Documentation is on a sliding scale; 1 = aware, 2 = competent, 3 = master, and 4 = expert. To evaluate the student-employee's performance, the instructor-employer utilizes observations, student-self assessments and observations, written evaluations, memos, and reports. In addition, student-employees are given a series of pencil and paper evaluations - quizzes, tests, research projects, final exams. Through this multi-plex assessment structure the instructor-employer has quality information to objectively assess the student-employee's degree of mastery of the skill standards. Yet, the moment of truth comes for both the student and instructor when the student-employee goes into the world of the industry partners. To date the students from The Virtual Workplace have received enthusiastic assessments from their industry employers. This is high praise and a high endorsement for the way The Virtual Workplace prepares students for the real workplace.

Oh sure, there are a few student-employees who have difficulty adapting to this new "hands-on" learning style; nevertheless, during the first semester many of those same students eventually adapt and thus survive and flourish in The Virtual Workplace. According to the instructors, attrition in their programs is low compared to other programs.

With this concise overview of The Virtual Workplace as a foundation, it is appropriate to discuss in greater detail the primary components of The Virtual Workplace.

manner, in addition to reading and conceptualizing. Students often work in teams, sharing knowledge and assisting each other.

The instructors prepare lessons and laboratory assignments but function more as resources or coaches, rather than conveyors of information. In this way, the focus of what happens in the classroom is shifted away from the teacher to the learners. In the biotechnology program at the Pease Center in Stratham, the program director created a series of key industry protocols and SOPs (discrete biotechnological procedures). The skill standards enabled faculty to incorporate industry practices as benchmarks. Achievement of those benchmarks in performance-based curricula requires students to successfully perform tasks which incorporate the skills, knowledge, and attributes in the skill standards.

Students all around New Hampshire are connected to this biotechnology program through the state's Internet-based asynchronous learning project. In this way they can engage in guided instruction to cover the gaps in their knowledge base, and receive credit for their online learning. Distance learners submit samples of their work as proof of skill attainment.

Instructional strategies that mirror the way real work is done and assessment methods that include performance-based measures, tied directly to industry-determined skill standards, help ensure that students in the four programs are well prepared to enter their respective industries upon graduation.

After three years of implementing skill standards-based curriculum in these four college programs, instructors share these lessons:

- Infusion of national skill standards has a far greater effect on the teaching/learning process—assuring that the subject matter is current with industry needs;
- As the instructional process is developed, there is a shift from instructor-centered to student-centered learning activities, and a marked shift from time-based to competency-based activities;
- The ability to replicate this educational approach in other colleges will depend upon the willingness of instructors in other colleges to change;
- The shared reform objectives across four very different program/ industry areas have created an exciting education reform dialogue among the lead faculty who have instituted these reforms.

EXAMPLE

NorthWest Center for Emerging Technologies (NWCET) at Bellevue Community College - *instructional implications of industry skill standards-based curriculum*

Implementing skill standards-based curriculum has implications for content and pedagogy. In *Building a Foundation for Tomorrow: Curriculum Development Kit,* staff at NWCET listed the changes in content, student outcomes expected, and methodology this way.

Changes in:	Traditional Classrooms	Skill Standards-Based
Content	• Technical content and foundation skills separated • More emphasis on attainment of technical skills • Foundation skills not explicit • Content-focused • Course-based	• Infusion of math and science to strengthen problem solving • Integration of technical content and foundation skills • Foundation skills are explicit • Competency-based • Module-based
Student Outcomes Expected	• General objectives • Emphasis on inputs • Students are exposed to content	• Learner outcomes are explicit and measurable • Emphasis on outputs
Methodology	• Teacher as expert and provider of lectures, demonstrations • Learner as receptacle • Delayed feedback • Narrow range of learning approaches	• Teacher as resource and mentor; one of many resources • Learner more self-directed and responsible for own learning • Immediate feedback • More flexible delivery approaches

EXAMPLE

University of South Florida, Competency-Based Vocational Education (CBVE) - *designing and using a competency-based system of learning*

The A to Z of designing, developing, and implementing competency-based training programs is captured in the pre-skill standards *Handbook for Developing Competency-Based Training Programs* (1982) by Professor William Blank of the University of South Florida. This handbook, rich with examples from secondary and post secondary skills training programs in the United States, points out the differences between managing individualized versus traditional training environments. (*See exhibit 5D*) Managing competency-based learning implies the need to have systems in place; this allows teachers to

- help students plan their work using contracts or performance agreements;
- keep track of daily progress using progress records and self-checks;
- assess students' progress through grading systems that reflect competency levels of achievement.

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Exhibit 5D: Crucial Questions to Consider Designing a Competency-Based System of Learning

Adapted from *Handbook for Developing Competency-Based Training Programs*

WHAT will students learn?:

1. What will the outcomes you wish students to master be called - standards, competencies, tasks, skills, goals or something else?
2. How will student competencies be identified for teach training program - taken directed from skill standards documents; adapting national skill standards to local employer needs; developing new skill standards; using existing DACUMs, catalogs of tasks, competencies; instructor-developed and worker-verified lists; or other strategies?
3. At what level will competencies be written: at the broad goal level, skill standard level, the duty level, the task level or sub-task level?
4. How will the student competencies for each program be listed and made available to students and others; what will this list be called?
5. How often - biannually, yearly, or as needed - will the competencies for each program be updated against changing skill standards?
6. Will competencies be "fit" into existing program lengths or will program lengths be base don the average time it takes students to master all required competencies successfully?
7. Will competencies be fitted into existing courses or units, or will students simply be enrolled in a program?
8. Will all students in a program be trained in a core set of competencies required in a cluster of related occupations or will they be given options to specialize?
9. Will there be a separate list of competencies for each specialization offered within the program?
10. Will there be a "core" required of all students regardless of specialization chosen?

HOW will students move through the program?

1. Who is the intended student population, and what are their learning characteristics?
2. How often will new students be allowed to enroll - weekly, biweekly, monthly?
3. Will new students be screened for certain essential prerequisites, or will the program focus entirely on exit competencies?
4. How will remediation of missing prerequisites be handled?

Professor William Blank of the University of South Florida, 1982

(continued exhibit 5D)

5. How will new students be oriented to the competency-based learning system?
6. Will instructor-student ratio be less, the same or greater than in the traditional approach?

WHEN will students learn each competency?

1. Will all students be required to master several basic competencies at the beginning of each program?
2. After the basics are mastered, will there be multiple starting points in those programs where this is feasible?
3. Will all students follow the same sequence of competencies, or will students be able to select the next competency if all prerequisites have been met?
4. How will students be shown multiple starting points, prerequisite learning, recommended sequences, and multiple exist points?
5. Will students be allowed, encourages or required to master one competency before going on to the next?
6. Can a student begin a new learning activity alone, only as a part of a small group, without instructor approval, only on certain days?
7. How will each individual student's training plan be determined and recorded?
8. How will each student's work be planned, how often, and how will it be recorded?
9. How will students be monitored to identify those that are having learning difficulties?
10. Can a student have access to learning materials days, evenings, weekends, holidays?

HOW will students learn?

1. Will the competency-based approach be phased-in, or will your institution jump right in?
2. What approach to curriculum will be taken during the first year or two of operation or transition?
3. Will learning modules be used as the primary means of delivering instruction, as a supplement, or at all?
4. Will learning packages, guides, modules, or something else be used to deliver instruction; what will they be called; how will the format be designed?
5. Will one format for modules be adopted throughout the entire institution, or can each department or program use its own?
6. Will learning resources be purchased, produced in-house, or both; if several media formats are available which one will be used; will one type of audiovisual equipment be used in all programs or several?
7. Will separate work stations be set up for presentation, practice, and testing; if so, how, where, and when?

Professor William Blank of the University of South Florida, 1982

(continued exhibit 5D)

8. Will students each get a copy of each module, will only a limited number be available to students; will none be given to students and the module given only to the instructor to guide the learning? Will students purchase modules as they would textbooks?
9. Will media, learning materials, and equipment be housed in each program area, in each wing of the facility, or in a central location?
10. Will traditional classrooms be converted to learning centers? If so how and when?

Dr. Blank makes recommendations for managing the CBVE learning environment by providing specific strategies for ways teachers can rearrange the physical environment, create a positive learning environment, help students complete learning packages, and seek support. This book provides an excellent checklist of questions for those planning to adopt a competency-based method of instruction.

University of South Florida, Learning Contracts - *between students and teachers*

Learning contracts or plans can help students and teachers manage learning. Learning contracts cover what will be learned, how and when it will be learned, as well as how to judge whether it has been learned. This strategy shifts the responsibility for achieving learning goals from the teacher to the student.

Learning Contract for Marking Term I

Name: ______________________________

Course: ______________________________

Learning Goal (Objective, Task, Activity, Project)	Resources to Be Used	Product(s), Outcomes, Achievements	Evidence	Quality Criteria

NorthWest Center for Emerging Technologies (NWCET) - *using scenarios to show the nature of work*

In *Building a Foundation for Tomorrow: Skill Standards for Information Technology,* NWCET presented scenarios to illustrate the nature of an information technology technician's work. These examples help students see the ways technical and academic skills are integrated in the workplace. The following two scenarios illustrate the work of an interactive digital media specialist.

Scenario 1

The president of your company has been invited to give a presentation on your company's flagship product or service. She has asked you to design a snappy yet informative overview using a computer presentation and animation software program. The presentation is scheduled to last 15 minutes. You are given the latest sales literature packages, along with the company marketing message that will be the backbone of her talk. In addition to an electronic file of the presentation, you are to provide detailed speaker's notes and handouts of the slides.

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Scenario 2

You are part of a team that has been asked to design a multimedia display for the local art museum. The display will appear at several kiosks located around the museum. The principle goals of the kiosks are to provide basic navigational assistance to museum visitors, give insight into different collections, and showcase the current exhibit. Your role is to participate in the overall design, and your primary emphasis lies in the visual design of the product.

The *Handbook for Developing Competency-Based Training Programs* (1982) suggests several strategies to promote thinking skills within a competency-based program. These strategies help establish a learning environment that provides opportunities for students to

- consider the strengths and weaknesses of opposing points of view;
- reflect on, discuss, and evaluate one's beliefs and actions;
- evaluate a wide range of alternatives when making decisions;
- raise ethical questions about consequences of actions and decisions on themselves and others;
- engage in collaborative inquiry;
- reflect on probing questions from the adult educator and adult learner, questions that emphasize the how and why as well as the what;
- engage in exploratory dialogue with themselves or others, fostering a sense of curiosity and inquisitiveness;
- value creative problem solving rather than conformity to "right" answers;
- identify implications of actions;
- challenge generalizations;
- identify, examine, and question assumptions.

Teachers can create learning environments that support reflective practices by encouraging students to

- question what, why, and how one does things, and ask what, why, and how others do things;
- seek alternatives;
- keep an open mind;
- compare and contrast;
- seek the framework, theoretical basis, and/or underlying rationale;
- view from various perspectives;
- ask "what if...?";
- ask for others' ideas and viewpoints;
- use prescriptive models only when adapted to the situation;
- consider consequences;

- hypothesize;
- synthesize and test;
- seek out, identify, and resolve problems.

EXAMPLE

Human Services Research Institute, Inc. - *developing activities linking the human services skill standards to core foundation skills*

Collecting data and maintaining records require skills in accurate observation and writing. These core skills were incorporated into the human services skill standards. For example, one of the supports skill standards is, "The competent community support human service professional maintains accurate records by collecting, compiling, and evaluating data that is then submitted to appropriate sources in a timely fashion" (HSRI 1996: 67). The structure of these standards, with their clear definition of skills and knowledge, allows for a wide range of real work applications. Using standards puts learning important basic skills within interesting contexts. This type of contextualization strengthens existing curriculum rather than becoming an "add on" to teachers' already full set of responsibilities. The following activities illustrate how the tasks of maintaining accurate records; collecting, compiling, and evaluating data; and submitting reports can be drawn into elementary and middle school activities.

Second- or third-grade students can practice the basics of documentation by telling the class everything they did—step by step—that morning from the time they got up until they entered the classroom. As a follow-up, students can observe a classmate or friend and write down everything that person did. In *fourth grade,* students observe various people in the school—teachers, volunteers, librarian, principal, counselors, secretary, nurse, or custodian—and note the various types of documentation they need to perform in their jobs. Students can discuss the different types of documentation—keep attendance, track student homework assignments, keep records of appointments, take minutes at meetings. For another activity, students can track the progress of a long-term class project using a calendar.

Middle-grade students can observe people at work during field trips and work site visits, recording the number of times and types of mathematics used in various occupations. Students can discuss their observations, and together, develop some conclusions about how mathematics is used in various careers.

3

What Instructional Strategies Are Used to Support Contextualized Learning in Programs to Prepare People for Success in the New Workplace?

Although we have learned that task mastery will help students get jobs, the one most likely to be successful once in the workplace is the learner who can integrate and use the academic, technical, and interpersonal skills he or she has acquired to resolve unanticipated problems arising on the job.

Contextual learning can place real workplace challenges before students as problems to solve or projects to carry out. These problem scenarios can be defined as authentic, real-life/work situations which place skills and knowledge in the context where mastery of routine performance must be demonstrated and a problem must be solved. These are excellent ways to help students learn and practice integrating their skills and knowledge.

To ensure future economic and career success of students, schools need to help them

- become self-reliant learners;
- learn how to follow directions;
- accept responsibility;
- adhere to work rules and precautions;
- ask questions and make decisions when necessary.

Scenario-based, contextual learning enables students to practice these workforce skills while acquiring the traditional academic knowledge valued in secondary schools. Scenario-based learning provides students the opportunity to use higher-order thinking skills in a guided environment. By organizing class members into collaborative groups, students take responsibility for their own learning. With guidance, they practice assessing what they already know about a subject in order to establish a framework for the new knowledge they are about to acquire. When students collect, analyze, and synthesize data, they draw on knowledge from different disciplines and integrate what they have learned—just as they would be required to do in the real world. This type of instruction is rarely in the discipline-bound classroom structure.

How Skill Standards Can Help

Teachers can use the information contained in skill-standards structure to solve challenging workplace problems. The standard integrates academic, technical, and employability skills and mirrors the real work people do. Using the skill standards, teachers and frontline workers can create scenarios that pinpoint the specific skills, knowledge, and attributes used to solve workplace problems. Once the scenarios are drafted, they can deconstruct them. This deconstruction process ensures that the intended learning outcomes are present and that the skills and knowledge emphasized are appropriate to the knowledge and skill levels of students. The deconstruction process also draws out the academic and cognitive thinking skills that may not appear in the task and skill lists. Skill standards support problem-based learning in three important ways:

- They can help teachers structure questions that guide student learning during problem solving, thus ensuring that student learning is focused on the targeted knowledge and skills;
- They can help teachers identify resource materials to facilitate students' information gathering in the initial stages of problem solving;
- They can help structure assessment rubrics to ensure that the skills and knowledge learned are evaluated and documented.

Using Real-Life Scenarios

Workplace scenarios present problems—commonly faced by frontline workers—that illustrate the skills and knowledge required within an industry. Workplace scenarios can help learners explore occupations and better understand the ways technical and academic skills and knowledge are needed in the workplace. They can also help incumbent workers set professional development goals. Workplace scenarios are also used in job interviews to assess a job applicant's abilities to resolve typical workplace problems. They are also used to assess the readiness of graduates to enter industry upon program completion.

Scenario I

One part of your laboratory responsibilities is to safely unpack and process biological samples. Demonstrate everything you would do to accomplish this. While unpacking samples one morning, you notice that one of the samples is leaking from the container. According to regulations, what should you do?

Assessment scenarios are contextual problems used to assess learners acquired level of skills and knowledge. Assessment scenarios also show how well they integrate their learning with higher-order thinking skills by asking specific questions that include assessment guidelines and scoring rubrics. Assessment rubrics are discussed in the chapter on assessment.

Planning Clothing to Take on a Family Vacation

Your family of five has decided to drive across country next July to visit relatives in Wyoming for a wedding. Along with your parents, your brother who is 8 and sister who is 13, you will be traveling in a vehicle large enough to transport five comfortably and able to accommodate a regulation-size carry-on piece of luggage for each family member. When planning the vacation, you suggested that the family travel via Texas in order to visit Auntie Judith, the frog, and the Alamo. You will be spending three weeks on the road staying with friends every night, except for three when you will be staying at a hotel. What clothing would you take and why? For the highest proficiency rating you must consider

- the number of items for the length of time you are on vacation
- ease of care
- space available
- the events you will attend
- the climates you will be experiencing
- layering
- multiuse items/coordination

Application scenarios illustrate how a skill or piece of knowledge is applied in work settings.

Workplace Applications

Company:	Sun Sportswear
Application:	Mixing colors for the screen printing process
Description:	A Sun employee must be able to mix custom colors for screen print applications
Suggested Activity:	Custom dying eggs. Using the four basic food colors, determine the ratio of blue to red to yellow to green for various custom colors. Then double or triple the size of the dye batch. The custom color should remain constant if the ratios have been followed.
Learning Goal 2	ELE Mathematics #5 — the student makes mathematical connections

Instructional scenarios developed by teacher-frontline worker teams, as discussed in the previous chapter, are useful in integrating academic, technical, and employability skills within the curriculum. The ideal instructional scenario will build upon students acquired skills. The scenario will introduce the desired skill standards and complementary academic skills and knowledge within the context of the desired industry. At certain levels (career awareness, exploration, ninth grade) instructional scenarios might be focused on broader issues affecting workplace success and more generic employability or SCANS skills. In many cases, an instructional scenario will focus on the skills to be developed, and can be organized around academic content supporting industry focus. Several examples of instructional scenarios follow.

Problem scenarios used for instructional purposes require students to

- draw on technical, academic, intellectual, and SCANS skills;
- decide on what knowledge and skills are applicable to the situation and critical to solving the problem;
- pose a solution to the situation by applying and integrating skills/knowledge appropriately and accurately.

The real-life/work situations brought into the classroom through contextual learning help students develop the following characteristics that employers seek in new hires:

- A foundation of technical skills and relevant conceptual knowledge;
- Willingness to upgrade the integration of computer-based communication for storage and retrieval of information as well as computer-driven manufacturing equipment;
- Clear and concise oral and written expression;
- The ability to work in teams and value the contributions of others;
- The ability to adapt to change with a minimum of frustration and retraining;

- The understanding of the structure of the organization and the individual's role within the corporate structure;
- The ability to recognize problems, ask questions, and pose reasonable solutions.

Employers need broadly trained workers with highly technical backgrounds who can keep up to date in a rapidly changing workplace, take responsibility for expensive technology, and show judgment and clear thinking under pressure.

CASE STUDY

Project SMART

Begun in 1992, Project SMART, in Cleveland, Ohio, was designed to provide students with the skills necessary—to solve problems and work in teams—to succeed in workplaces. After participating in training on both teaming and constructivist learning, teachers were ready to develop and implement the first steps of problem-based learning. Using manufacturing skill standards developed by local frontline workers and workplace scenarios, teachers developed instructional scenarios to meet local academic learning requirements. Following are several examples of the first *instructional scenarios* developed by teachers for this manufacturing program.

Developing instructional scenarios which build on skill standards for manufacturing

Algebra: Payroll and Accounting (Semester Project)

Your class has decided to start a business. You need to understand various ways salaries can be paid; how deductions are taken; what union regulations and dues affect the company; what benefits federal, state, and city tax rules and regulations apply to the company; and what benefits the company should offer. You also need to know what your responsibilities and costs will be as an employer. Prepare a business plan to cover all these problems, and design an accounting payroll system and a pay-stub receipt for employees. You must also set up a record-keeping system to track pay recipients.

Geometry: Aquarium Design

The major city you work in is planning to expand its existing aquarium which is the largest museum in the city attracting thousands of visitors and generating tourist revenues for the city. While the new tanks are being constructed, you have been hired to work with the marine biologists to design temporary homes for the fish in the collection. You must design several small tanks which will be all glass and allow viewers to see the fish in small exhibits during the construction. Tanks need to be designed to accommodate the following fishes:

> *Moray eel.* They are five feet long. They live in reef crevices in the wild and prefer a relatively confined space. Your biologist recommends a narrow cylindrical tank, most of which would be built into a simulated cave environment.

CASE STUDY CONT'D

Tiger shark. The aquarium's tiger shark is still very young and only a little bit over two feet long. Tiger sharks are creatures of the open water, however. Like most sharks, the tiger shark needs to swim constantly to move water over its gills. A hemispherical tank has been recommended, and it will have to be large enough to give the shark plenty of room to swim around. Keep in mind that even though this is a temporary housing, construction can take a long time and sharks grow quickly. Tiger sharks can reach a size of ten feet or more.

Clownfish and Sea Anemones. Clownfish live in a symbiotic relationship with the sea anemones, and the anemones require a surface to attach themselves to. To provide this surface and give visitors the best possible view, it has been decided that a pyramidal tank should hold this exhibit. The clownfish are small (about 3-5 inches long). Anemones range in size from 3-8 inches in diameter. You have 12 clownfish and 16 anemones.

Design three smaller tanks, one cylindrical, one hemispherical, and one pyramidal. Provide specifications including the amount of glass needed to construct each one and the amount of water each will hold.

Trigonometry: Bicycle Design

You work for a company that manufactures customized bicycles. Your project manager is concerned about the competition's new model. He asks your team to design a new bike. He explains that the company wishes to keep certain parts at the current specifications. Your team must work with these parts in the following dimensions: pedal arms, 17 cm long; wheels, 70 cm in diameter; seat tube angle is 8 degrees of the vertical axis. The top tube is parallel with the ground. The fork should have a rake. Pedals must clear the ground by 12 cm. Determine the angle and lengths of tubes for a person with an inseam of 80 cm. Explain your design and the angles in a new design proposal.

EXAMPLE

Education Development Center, Inc. (EDC) - *using criteria to ensure utility and rigor of instructional scenarios, and to ensure appropriate balances within a bank of scenarios*

EDC has developed the following criteria for individual scenarios and for groups of scenarios presented as a whole. The criteria for the bank of scenarios ensure that there is an appropriate balance within each scenario around important and significant issues to the learning community.

Each instructional scenario should:

- contain a challenging problem;
- be interesting and motivating;
- be clearly written and understandable;
- contain sufficient information to use as a base for a learning activity;

- deal with important subject matter that requires serious thought;
- reflect authentic workplace or other real-life situations;
- integrate academic content appropriate to the learners' needs;
- integrate skill standards, or technical skills;
- reflect SCANS;
- be applicable to more than one industry.

The bank of scenarios should

- cover a sufficient range or balance of content (technical/skill) standards required in a variety of careers and life or work settings;
- cover a sufficient range of local academic learning standards;
- cover a sufficient range of SCANS skills;
- provide a balance of examples from different industries and community situations;
- provide a balance of life or work situations;
- reflect equity and diversity by focusing on a variety of names, situations, and images that are drawn from different ethnic, cultural, gender, and class groupings.

EXAMPLE

Ohio's ITAC - *developing criteria for core, cluster, and specialization scenarios*

In thinking through the ITAC (Integrated Technical and Academic Competencies) model, the Ohio Department of Education uses the following criteria to guide development of scenarios for their three levels of career-focused education.

Core	**Cluster**	**Specialization**
Appropriate for all students	Common across a cluster	Specific to the occupation or industry
Central to all work	Central to a cluster or career	Central to a specific occupation or industry
Problem or task related to real-life and work, community, workplace, family	Related to work in a career cluster or group of occupations	Related to a specific occupation or industry
Focus on core competencies	Focus on Strand	Focus on specialization
Connects to significant academic content beyond the competencies needed to solve the problem		
Scenarios situated in an academic class setting	Situated in an academic or a technical setting	Situated in a vocational class or shop
Academic teachers with support of others	Academic and/or technical teachers	Technical teachers with academic/related teacher support
		Mirror as closely as possible a work situation specific to the industry

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EXAMPLE

Family and Consumer Sciences (FACS) Teachers - *creating resource lists of authentic work or life situations for use in scenario development*

At the May 1998 Assembly of States in Indianapolis, Indiana, Family and Consumer Sciences (FACS) teachers and administrators drafted their first instructional scenarios and created the following list of situations to be used as a resource. The list is a useful tool in the scenario development process. It helps teachers build scenarios that provide an authentic context (work, life, and school) for demonstrating required skills and knowledge. This list has also helped to guide teachers from building other content specializations to developing their own situations, which reflect the authentic life or work challenges found in their fields.

Sample Situations from Family and Consumer Sciences

- Nutritionist preparing a menu at a senior citizen's home;
- Preschool staff preparing snacks for children (no peanuts);
- Boy scouts preparing menus for weekend camping;
- Planning a menu for pre-marathon runners;
- Designing a weight-reduction diet;
- Coach monitoring a checking account activity for the school's sports club;
- Future Homemakers of America preparing a budget (spreadsheet) for a school dance;
- Student developing a budget for a summer wardrobe;
- Parent developing a college financial plan;
- Teenager developing a plan to buy a car;
- Seventh grader picking careers to explore;
- Eighth grader interpreting career-interest assessments;
- Graduate identifying a preferred lifestyle;
- High school student setting career goals;
- Twelfth grader developing a career plan;
- Middle school student deciding on a high school magnet program.

Using sample situations along with agreed-upon criteria, teachers can draft instructional scenarios for use in classrooms, shops, on worksite visits, and in the community.

EXAMPLE

Minuteman Science-Technology High School and Adult Career Center Biotechnology Academy - *using work teams and the discovery process to isolate casein from milk*

At the Biotechnology Academy in Minuteman Science-Technology High School and Adult Career Center, in Lexington, Massachusetts, the procedure for carrying out an isolation of the protein casein from milk is performed in a team-oriented environment during junior year. The students are divided into three to five teams, and asked to act as "analytical chemists" solving problems such as this one:

Scenario I

Setting: USDA office in Madison, Wisconsin. Your field inspector has been monitoring the milk production at four local dairies. He has become suspicious that two of the dairies are modifying the protein content of the milk product. As a result, he has brought back samples from the four dairies. Are the samples significantly different from one another?

Teams are asked to solve this problem by performing a casein isolation on the four samples. After the teams have completed their analysis, each team records its own data as well as data from the other teams. Then they perform tests to determine if the samples differ significantly. This type of statistical analysis is a continuation of the training in experimental design and analysis started in the freshman year. Through this method, math skills are integrated into the instructional program.

This casein isolation experiment ties together skills and knowledge found in the standards. The activity includes many of the technical skills from technical communication, safety, basic and specific lab skills, specific and quality assurance; the academic knowledge from general science, biology, molecular biology, and chemistry; and the employability skills from resource management, interpersonal skills, information, and thinking/reasoning. The Biotechnology Academy's casein isolation procedure is an exemplary model of using student teams to perform lab experiments and compare results within a given scenario.

Team-based, problem-centered learning teaches students to respect each other's unique talents. Students learn that together they have the skills to uncover new solutions which were not available to them working independently. As the problems become more complex, the degree of organizational cooperation needed to find a solution draw students into more frequent collaboration. The problem scenarios are designed to introduce students incrementally to group work, task analysis, estimation of cost, material and labor, the establishment of a timeline, and division of responsibilities. Most scenarios result in the group production of a tangible end-product. This product could be a computer model, an oral presentation, a publishable written work, a reenactment, an annual report, or other commodity valued in the workplace. Working together against a deadline provides the class with experience in producing work of high quality within the parameters of the customer's specifications, operating within cost constraints, and depending on coworkers to do the same.

An additional advantage of problem-based learning is that it enables the teacher to provide individuals and small groups with specialized attention. It radically changes the role of the teacher in the classroom. Quickly, teachers will realize that students no longer perceive them as attendance takers and disciplinarians, but rather as mentors, guides, and facilitators—in other words, as educators.

Creating Problem-Based Learning Lesson Plans

Problem-based learning (PBL), is a methodology which can focus contextual learning on the solving of authentic workplace problems. Problem-based learning has its roots in programs designed to prepare physicians for career success, and has been used to structure career preparation programs for physicians at some of the nation's most notable medical schools. PBL guides students through a process in which they define the problem, identify what they need to learn to solve the problem, identify and access resources, and pose possible solutions. Problem-based learning is used by many academic education programs to help students develop deep thinking and analytical skills while learning to solve complex problems.

Adaptations of the problem-based learning methodology, along with the task mastery of competency-based learning, forms a balanced learning experience for people preparing to enter the highly technical new workplace.

EXAMPLE

Education Development Center, Inc. (EDC) - *using the problem-based learning lesson format*

EDC adapted a problem-based learning methodology to skill standards-based programs. This includes a format for introducing students to problem-based learning through a simple set of questions.

- How will you know when the problem has been solved?
- What do you need to know and be able to do to solve this problem?
- Who or What are your resources?
- What actions will you take to solve the problem?
- How will you present your solution(s) to others?

To ensure that students maintain their interest and momentum in solving the problem, teachers need to anticipate the answers to those questions. They also should have classroom resources available for students to begin their work. This problem-based learning design asks teachers to develop a set of guiding questions to help keep students on track with their learning, and help them move toward the skills and knowledge targeted for the activity. Once oriented, students adapt quickly and easily to this learning methodology.

EXAMPLE

Project SMART - *problem-based lesson format in action*

The Women in the Workforce activity was developed for ninth-grade classes in manufacturing programs. Its generic appeal makes it a good activity for many classes. The sample lesson includes all relevant and important information the teacher would need to implement this instructional scenario; namely, the scenario, academic skills, industry skills, length of activity, materials needed, suggested evaluation criteria, integration areas, activities, and resources. It also includes the four-part instructional scenario format which uses four essential questions: What is the problem? How will we know it has been solved? What do we need to know and be able to do to solve the problem? What or Who are our resources? The lesson includes guiding questions a teacher might ask students to prompt their focus on specific learning topics. The problem-based activity format helps teachers and students organize their learning. The guiding questions are key to helping teachers move students toward successful completion of the scenario. (*See exhibit 5E.*)

Exhibit 5E: Sample Lesson

SUBJECT: AMERICAN HISTORY - WOMEN'S ISSUES: GRADE 9

Problem Scenario:

Your high school holds a career day with local manufacturing companies each year. One of the panels deals with women's issues. The panel will discuss women in the workforce, women in non-traditional jobs and women in manufacturing, their work roles and how they evolved. The principal asks your class to participate in that panel. You must organize the section on the history of women in industry, writing the facilitator's introductory remarks (introducing the panel discussion) as well as her 10 major discussion questions; provide handouts, research background material for panelists and use overhead transparencies (minimum of 3).

Academic Skills:

- Compare and contrast points of agreement and disagreement among sources
- Use research information including audio visual and computer links
- Apply inference skills to compare sociality changes
- Skills that enable a student to participate as a team member
- Skimming and scanning, summarization, note taking

Manufacturing Skills:

A-1	Use listening skills
A-3	Communicate vital information verbally and in writing
A-10	Work as a team (within a cell structure)
A-13	Ask for feedback
A-14	Meet deadlines
B-7	Give oral reports

Length of Activity: One to four weeks

Week One: Discuss problem, develop workplan, research and organize information;
Week Two & Three: Organize presentation, prepare presentation materials, rehearse;
Week Four: Present panel, assess its effectiveness, and debrief with your team.

Materials and Teacher-made Instructional Materials: As appropriate

Optional:

- Locate motivational posters such as those used in WWII to encourage women in the workplace such as Rosie the Riveter.
- Prepare and present this panel discussion to other classes, parent groups, employee groups or public access radio or TV;
- Interview sheets to aid students;
- Organization sheet to help students research information;
- Make video tape of panel discussion.

(continued exhibit 5E)

Evaluation:

Suggested Criteria:

- teams researched topics prepared, organized and presented information to the class
- materials prepared convey intended meaning, are clear and easily understood by the audience
- Students chose appropriate topics, questions for a panel discussion on Women in the Workforce
- Student presented different views and were knowledgeable about the historical events leading to moving more women in the workforce, changing roles and the role of woman today. Demonstrated in the chosen topics or/and panel discussion.

Integration Areas:

- English-writing
- Research
- Oral communication
- Computers
- Word processing
- Desktop publishing
- Internet links

Further Activities:

- Students can interview women who worked during WWI and WWII
- Student can interview women about how they perceive the changes in their roles and working over the years.
- Students can make a chart answers by the dates when women interviewed started working.
- Students can ask men about how they perceive the changes in women's role in the workforce and compare with the women

Suggested Resources:

- WEEA PUBLISHING CENTER at Education Development Ctr (617-969-7100, X2477)

EXAMPLE

Operation Breakthrough! - *teacher plans lessons by anticipating students' questions*

In Operation Breakthrough! a Texas chemistry teacher used a format similar to that applied in Project SMART to capture and share the experiments he conducted during his summer externship at a local chemical laboratory. In this example, the teacher planned his lesson by anticipating how the students would answer the key questions and by adding topics and questions he wanted to focus on during the lesson.

EXAMPLE

Education Development Center, Inc. (EDC) - *"baby talk is for babies;" skill standards help teachers use authentic terminology with students*

In working with school systems to develop skill standards-based career pathways, EDC found that many elementary, middle, and high school teachers were unfamiliar with technical terminology related to their own work. For example, almost all science teachers read and follow the MSDS (Materials Safety Data Sheet) when unpacking the powders for fourth-grade experiments or the polywog and moth cocoons used in grades 1 and 2. Yet they are unfamiliar with the term *MSDS*. It is an essential term for technical workers who handle sensitive materials. Science teachers often are also unfamiliar with the terms *protocol* (the step-by-step process required for a test or experiment) and *SOP* (Standard Operating Procedure), both terms used by scientists in industry settings. Teachers reported that they don't use technical terminology with students because they were not taught this terminology in their teacher training programs. Reviewing industry skill standards as career pathways are constructed to help teachers identify the language gaps between the "baby talk" used with students and the "real talk" found in the technical terminology of the skill standards.

Conclusion

Communities implementing skill standards seem to be focusing on one of two major instructional strategies — *competency-based learning* or *contextual learning*. Developing and using either learning methodology is challenging to the new teacher. Combining the rigor of competency-based learning with the challenges generated by contextual learning can create exciting learning experiences for youth and adults preparing for further education and workplace success. A number of useful tools and processes can help teachers plan, develop, and implement these instructional strategies in their education-to-work programs. Following the instructional scenario method to create standards-based contextual learning experiences, and using some of the simple tools mentioned, can help less experienced teachers use these methodologies with ease and success.

Enhancing Professional Development

There are significant professional development challenges inherent in preparing teachers, counselors, work supervisors, employers and frontline workers to implement successful industry skill standards. In education and employment settings, the implementation process asks us to rethink content (*what* people learn) and pedagogical process (*how* people learn), as well as where learning can take place.

In addition to keeping up-to-date with changing content, teachers are challenged to learn the "new ways of working" that characterize today's most successful enterprises. Educators are further challenged to learn new workplace vocabulary which is redefining the culture of work, such as *coopetition*, "the ways competitive companies are cooperating on joint ventures"; *valueadded*; or *ROI*, "return on investment." Unfortunately, even the best technical educators can be isolated from the dramatic changes in technology systems, new products and theories, and organizational practices in industry, including the changing responsibilities of workers.

All these changes require educators to redirect their own learning as they ask, What do our students need to learn to be successful in life and work? What ways of learning do they need to experience to make the most successful transition from school-to-work in professional, technical, and service careers? Where must learning take place to maximize their learning experience? In other words, How do we reform our "schooling" to provide the greatest ROI for our students, as well as for the other stakeholders?

The Department of Education's *School-Based Reform: Lessons from a National Study* (1995) reported that schools and communities successful in education reform provided challenging learning experiences, and a school culture that nurtured staff collaboration and participation in decision making. In addition, they possessed meaningful opportunities for professional growth, including

- teaching teams developing strategic plans that allowed for sustained, coherent immersion in an area;
- train-the-trainer models, in which knowledgeable teachers train their cohorts;
- teaming and coaching, in which teachers learn from experts and from each other;
- teacher visits to other classes to see new ideas in action;
- alliances with universities and other pools of experts;
- pooling of resources among groups of schools to share training experiences and personnel.

These important components can be applied to programs implementing skill standards. They provide educators with a quality check for their professional development plans.

This section shares examples of innovative ways to enhance the professional development of educators who are implementing skill standards-based learning. Although some examples are industry-specific, the approaches and methodologies are transferable to all industry education programs and useful for teachers at various educational levels.

Key Questions

1. What varied kinds of professional development are being utilized by educators to prepare learners for success in the workforce?
2. What new approaches to professional development, including working with industry, are being used to improve teachers' capacities?

1 What varied kinds of professional development are being utilized by educators to prepare learners for success in the workforce?

Our nation's schools are currently undergoing profound reform in curriculum, instruction, and assessment. Preparing teachers to participate in and assume leadership of these reforms is essential. Teachers' professional development is an increasingly important component of education change and improvement. Studies have shown that effective teacher development programs often

- occur during the teachers' regular workday;
- bring a consistent group of teachers together over time;
- give teachers access to current expertise in their subject area;
- offer teachers sufficient time to reflect on challenging ideas;
- encourage teachers to adapt innovation to their own teaching;
- provide opportunities for collaboration with other teachers.

In a climate of strenuous budget reductions, most school districts are finding it difficult to fund their in-service staff development programs. Others require teachers to participate in staff development activities on their own time, adding more burdens to the teachers' after-school hours, already crowded with support of students' social activities, sports, and class preparation.

How Skill Standards Can Help

Industry skill standards provide a useful structure to help focus teachers' professional development experience. As teachers learn about industry skill and knowledge needs, they develop strategies to integrate them into their programs and curriculum. They can learn to integrate content horizontally (across academic and technical disciplines) and vertically (across education levels). By using real-life scenarios, technical and academic teachers see the value of each other's contributions in preparing students for their future lives. Teachers learn new ways of teaching as they relate their own pedagogy to the organizational and behavioral requirements of industry. Academic teachers begin to focus on problem solving, decision making, team-based projects, and other innovative approaches to learning. For technical teachers, professional development focused on industry skill standards can ensure they use the skills and knowledge expected of frontline workers with their students. The need to continually update the standards engages teachers in continuous, lifelong learning. They will need to redesign programs and curriculum to stay current with industry expectations. Professional development, based on the use of industry standards, helps teachers realize their vital role in a larger education-to-employment system; their work has direct implications for workforce and economic development.

Following are examples of common models of teacher/instructor professional development concerned with education for employment.

Experimental Learnings

Hands-on, experiential learning is valued by both academic and technical educators. Both see this as a way to deepen learning and to provide the connections between abstract concepts and their applications in life and work. Hands-on, experiential learning is especially valuable for pre-service educators (K-16) who may have had limited experience applying their content in noneducational work settings.

EXAMPLE

Keene State College - *New Hampshire community college educators are learning by doing*

When the New Hampshire State Community Technical College System wanted to develop college instructors' skills in educational computing, Keene State College implemented a weeklong professional development session. It began with an overview of current computer uses in elementary schools and industry. It also included information on what futurists were saying about computers. Participating college professors formed small groups to discuss implications for their teaching. The next day they were assigned computers and asked to write about the influence of computers on the future, implications for their graduating students, and implications for their teaching. Instead of being taught to use the computer, they were given a task to do on the computer. On the third day they presented their tasks to the full group and then revised their work. The fourth day they participated in a nationwide chat group with national experts and other teachers to communicate about this topic. Another day they generated a list of classroom resources and met with a group of mentors. At the time of this professional development session, they did not have access for themselves, or their students, to computers or a computer purchasing program. On the last day a task force was created to move the initiative forward. By the end of the week they had solid hands-on experiences to help guide their planning.

Summer Institutes

Many schools and school systems view the summer as an opportunity to provide professional development through intensive summer institutes and workshops. In addition, many technical-vocational communities use the beginning and end of summer to engage teachers in required professional development credits for continued certification.

EXAMPLE

EDVOTEK Workshops - *EDVOTEK, Inc. manufactures and supplies biotechnology equipment and experimental modules for undergraduate science education*

EDVOTEK professional development courses in biotechnology are designed to meet a variety of training needs and interests. Course activities focus on a combination of theory, experiments, laboratory safety, data analysis and curriculum implementation. Experiments are designed to facilitate incorporation of biotechnology in teaching laboratories and provide participants opportunities to perform frequently used techniques in experimental research applications of biotechnology. In 1999 three courses were offered: Basics of Classroom Molecular Biology; Classroom DNA Sequencing and PCR; and Protein Expression, Purification & Characterization. The workshops are held in the Washington, D.C. Metro Area and operate in partnership with Georgetown University Faculty *(See exhibit 6A)*.

CASE STUDY

Chautauqua Short-Course Program

Chautauqua Short Courses are an annual series of forums in which scholars at the frontiers of various sciences meet intensively for several days with undergraduate college teachers of science. The seminars are conducted primarily for teachers from two- to four-year colleges, although teachers of advanced high-school courses also find Chautauqua offerings useful. These forums provide an opportunity for invited scholars to communicate new knowledge, concepts, and techniques directly to college teachers in ways that are immediately beneficial to their teaching. The primary aim is to enable undergraduate teachers in the sciences to keep their teaching current in content and method.

Teachers of undergraduate students in degree-granting institutions in the United States, who teach in the natural or social sciences, mathematics, or engineering are eligible for participation. Course offerings of the Chautauqua Short-Course Program reflect this range of academic training. The following is a sample of the 83 courses offered during the 1999 Chautauqua Program:

Exhibit 6A: EDVOTEK Workshops

EDVOTEK® Workshops

to be held in the Washington D.C. Metro Area

in partnership with Georgetown University Faculty

EDVOTEK courses in biotechnology are designed to meet a variety of training needs and interests. EDVOTEK course activities focus on: 1) theory, 2) experiments, 3) laboratory safety, 4) data analysis, and 5) curriculum implementation. Experiments are designed to facilitate incorporation of biotechnology in teaching laboratories and provide participants opportunities to perform frequently used techniques in experimental research applications of biotechnology.

Jan. 15-16, 1999	**Basics of Classroom Molecular Biology**
June 18-19, 1999	**Classroom DNA Sequencing and PCR**
Oct. 15-16, 1999	**Protein Expression, Purification & Characterization**

The course fee is $225 for two-day courses. A 25% discount is provided to those who register for more than one course. Off-campus housing is available for short courses. Participants are responsible for all lodging expenses, meals and travel, including ground transportation.

Call 1-800-EDVOTEK
for a course description and registration form.
(Ask for T.K.)

CASE STUDY CONT.'D

- **Single Mothers, Absent Fathers and Poverty Policy**
  Instructor: Kathryn Edin, University of Pennsylvania
- **Biotechnology Theory and Practice for the 21st Century**
  Instructors: Jack G. Chirikjian, Georgetown University
  Karen M. Graf, EDVOTEK, Inc.
- **Archaeoastronomy in Mayan Belize**
  Instructor: R. Robert Robbins, The University of Texas at Austin
- **Ecology of Marine Mammals in Monterey Bay, California**
  Instructor: James T. Harvey, Moss Landing Laboratories

From year to year, the program rotates courses among different regions of the country. Currently Chautauqua short courses are offered at nine field locations in the United States and Puerto Rico. *(See exhibit 6B.)*

The Program is a cooperative enterprise which involves: college teachers (participants) who take part with the encouragement of their home institutions; the various scholars who teach the courses (Course Directors); the Regional Field Centers which are responsible for arranging and hosting the short courses; the Council of Chautauqua Field Center Directors which provides the national administrative focus of the program; and the National Science Foundation which provides the financial support.

EXAMPLE

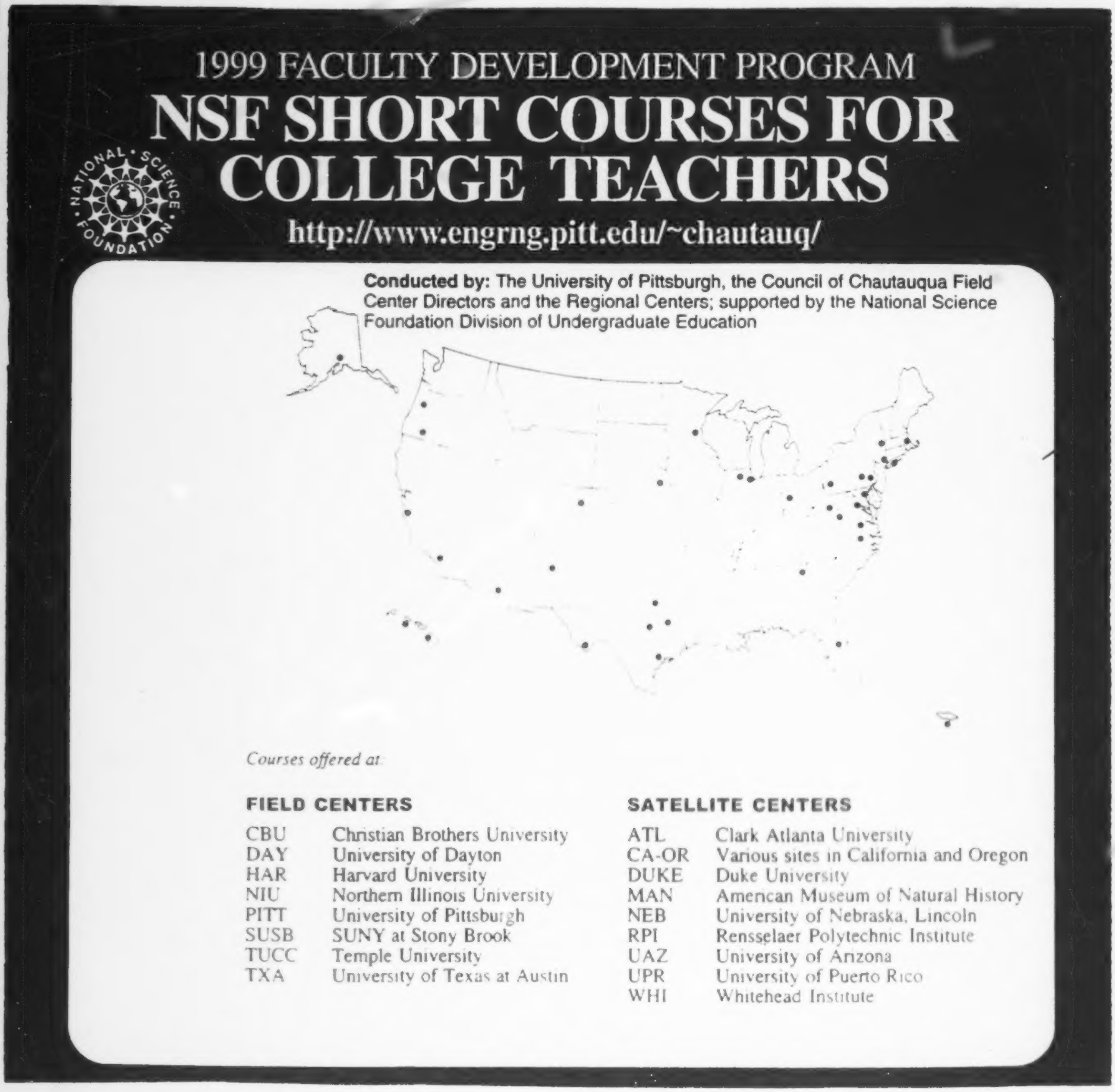
NorthWest Center for Emerging Technologies (NWCET) - *learning how to implement information technology skill standards*

NWCET, located at Bellevue Community College in Washington State, hosts summer institutes to build the capacity of secondary and postsecondary faculty who are implementing the Information Technology skill standards in their programs and courses. Through short, focused, and intensive workshops, NWCET provides faculty with opportunities to meet their immediate implementation needs. Building Skill Standards-Based Information Technology Programs and Curricula is a three and a half day summer institute for 30 high school and community college instructors. The institute provides a foundation for educators involved in the development and implementation of curriculum linked to the IT skill standards. It focuses on general strategies for

- developing and implementing competency-based and problem-based learning models;
- relating IT skill standards to existing or emerging academic and program standards;
- integrating skill standards into academic and technical courses and course sequencing.

Participants from high schools examine concrete examples and activities based on models from the NWCET Tech Prep Information Technology curriculum. Participants from community/technical colleges focus on concrete examples and activities based on models from NWCET's Information Technology Curriculum Development Kit.

Exhibit 6B: Chautauqua Short-Course Program



1999 FACULTY DEVELOPMENT PROGRAM

NSF SHORT COURSES FOR COLLEGE TEACHERS

NATIONAL SCIENCE FOUNDATION

http://www.engrng.pitt.edu/~chautauq/

Conducted by: The University of Pittsburgh, the Council of Chautauqua Field Center Directors and the Regional Centers; supported by the National Science Foundation Division of Undergraduate Education

Courses offered at:

FIELD CENTERS

CBU	Christian Brothers University
DAY	University of Dayton
HAR	Harvard University
NIU	Northern Illinois University
PITT	University of Pittsburgh
SUSB	SUNY at Stony Brook
TUCC	Temple University
TXA	University of Texas at Austin

SATELLITE CENTERS

ATL	Clark Atlanta University
CA-OR	Various sites in California and Oregon
DUKE	Duke University
MAN	American Museum of Natural History
NEB	University of Nebraska, Lincoln
RPI	Rensselaer Polytechnic Institute
UAZ	University of Arizona
UPR	University of Puerto Rico
WHI	Whitehead Institute

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Traveling Vans

Some new initiatives requiring expensive equipment and materials use traveling vans to provide large numbers of high school teachers and students access to learning experiences they could not otherwise have. The use of these vans is particularly helpful for school programs that require the introduction of "wet" laboratories and other expensive work tools and equipment. Teachers who staff the vans provide professional development as they travel to area schools. They bring other teachers new opportunities to learn through hands-on experiences with equipment and materials, short units, projects, and kits. As teachers are introduced to new content and pedagogy, they build their own capacity to integrate these ideas and methods into their classroom-based curriculum.

EXAMPLE

Genentech, CityLab - *using mobile laboratories to reach teachers and students*

In the early 1980s the Boston Public Schools computer bus brought a mobile computer lab to schools so that teachers and students could have access to equipment to develop computer literacy skills. Genentech Corporation has donated a mobile van to share laboratory experiences with teachers and students all around the San Francisco Bay Area. The van is used to transport materials, equipment, instructional resources, and kits that contain experiments for students to use in their classrooms.

CityLab's "mobile laboratory" is a 40-foot, self-contained laboratory facility designed to accommodate all of the laboratory activities offered by CityLab. The mobile laboratory travels to schools and remains on site for extended periods to provide teachers and students access to equipment, experiments, and protocols. This brings continuity and enrichment to the schools' laboratory experiences. (*See exhibit 6C.*)

Role Play

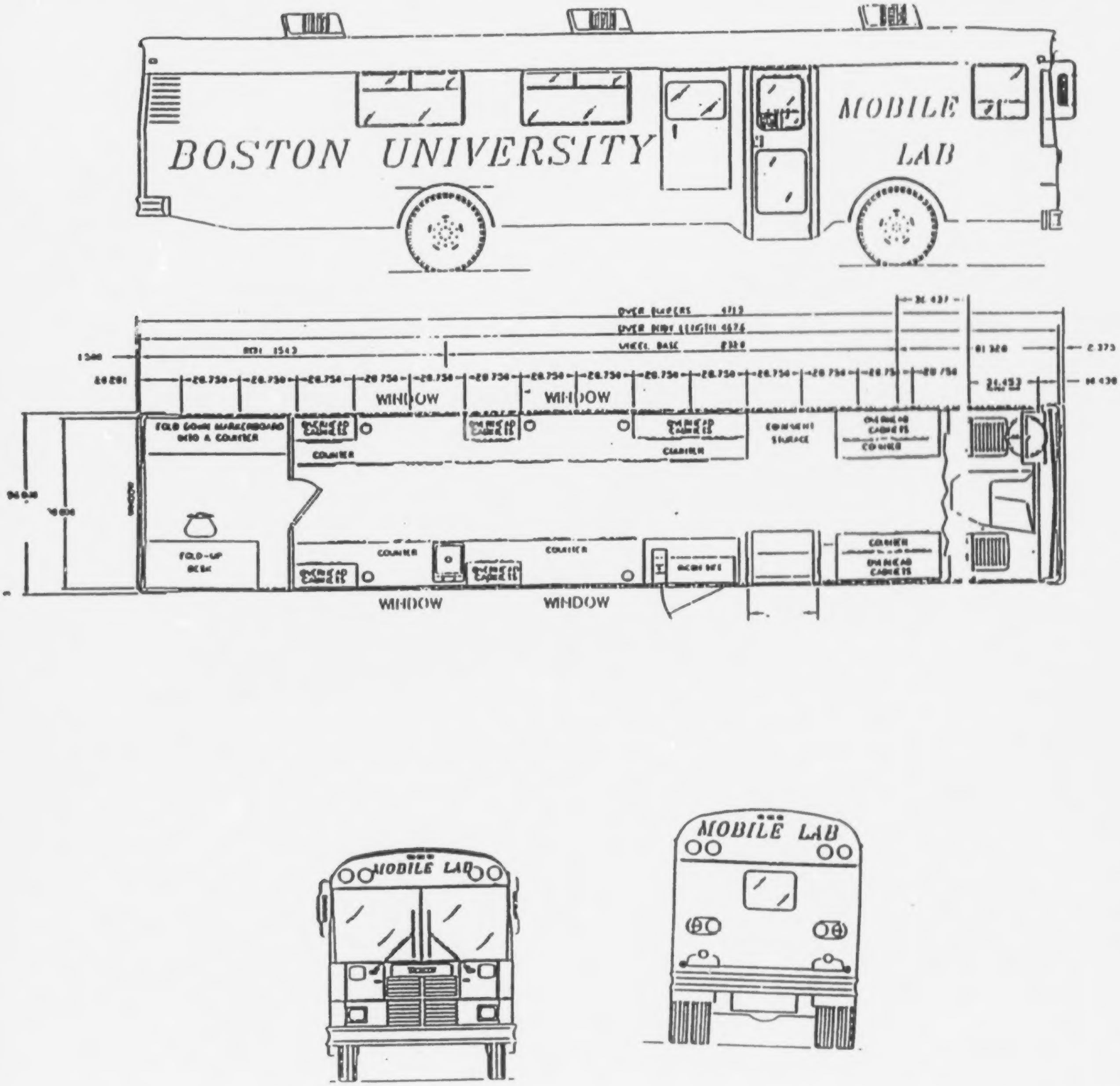
Sometimes it is difficult to find placements for teachers in industry settings. Role plays and simulations help bring teachers closer to the workplace experience without having them actually there for extended periods of time. The following example illustrates one role-play experience in which teachers interact with industry representatives to learn about and use manufacturing skill standards in teaching projects.

EXAMPLE

Youth Opportunities Unlimited, Inc., - *Project SMART, a long-term commitment to continuous learning by teachers*

When Youth Opportunities Unlimited, Inc. of Cleveland, Ohio, began Project SMART (School for Manufacturing and Related Technologies) in 1992, emphasis was placed on professional development. Each summer, teacher teams participated in a two-week intensive professional development institute in which teachers learned about both education and workplace issues. Teachers toured workplaces using new ways of working, such as "cell structures," participatory management, and cross-trained worker teams in large manufacturing plants. They discussed what they observed with management and frontline workers. One summer, two teams of Project SMART teachers were challenged by a "client" (played by one of their business partners) to investigate the feasibility of manufacturing a new board game in

Exhibit 6C: CityLab Mobile Laboratory



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Cleveland. The two competing teams created a game, developed a business plan, a manufacturing plan, and produced a prototype. In that process, teachers experienced what it is like to design a product, develop specifications, negotiate price parts with local vendors, work with local manufacturing firms to price production costs, write up the plans, and produce a prototype. At the end of the two weeks, teams presented their prototypes to their "clients," who made decisions about whether or not they would invest in the manufacture of these products. Through this experience teachers developed a sufficient level of comfort with the world of manufacturing to help students carry out manufacturing projects during the school year.

Peer Teaching and Pairing of Teachers/Scientists

Peer teaching and peer support have long been recognized as successful ways to build the capacity of teachers to handle new content and instructional methodologies in nonthreatening environments. The following shows how one program uses this professional development model to enable teachers new to a program to learn from experienced teachers how to work with new curriculum content and instructional strategies.

EXAMPLE

Berkeley Biotechnology Education Inc. (BBEI) - *experienced teachers assisting new teachers*

In 1992 the BBEI program began at Berkeley High School. During subsequent years, the program expanded. In 1996 BBEI brought its program to Freemont High School in Oakland. BBEI created a peer teaching component in which Berkeley High School teachers assisted Fremont High School teachers to incorporate the program and its goals. During regularly scheduled sessions, Berkeley teachers assisted Fremont teachers with the philosophy, curriculum pedagogy, and assessment processes developed in the Berkeley program. With assistance from the BBEI executive director, teachers helped plan every day of each three-week learning session, and identified and assembled needed equipment and materials. BBEI's executive director support to teachers beginning to use the curriculum by serving as a lab assistant. The coordinator also attended classes and labs, made observations, tutored students, and gave feedback to the teacher.

At the beginning of a new curriculum, BBEI believes it is important to have more than one adult in the room. Although it is costly, they believe it is worthwhile to team up a person who has taught a course with a person who has never taught it, so that the new person can be brought into the cycle. Even with a well-developed curriculum, teachers have difficulty implementing it the first time. At BBEI, teachers are given the opportunity to "learn and do" the labs as the students will do them. They are given needed support to learn about equipment they may not have used.

BBEI also has developed an instrumentation course for the community college in their partnership. The college pays for one instructor, and BBEI pays for the other in chemistry and biology.

Teaming across levels also has been a powerful way to develop partnerships. BBEI has a community college instructor and a high school teacher go as a team into workplaces where students are doing internships or coop work to obtain feedback from students and supervisors. During these visits, the teachers learn what students need to know on the job and what the expectations are for a successful internship activity. They then can discuss their findings and apply them to their articulated curriculum.

Industry Volunteers in the Classroom

The Industry Volunteers in the Classroom model provides professional development time for teachers by matching them up with volunteers from local companies that regularly replace them in the classroom. This industry volunteer model offers a way for business and industry to support professional development for local classroom teachers by contributing an important resource: release time. It allows teachers to meet together regularly during school hours without hiring costly substitute teachers and it mines the expertise of local community volunteers whose work experience is relevant to the teacher's subject matter. The following case study is an interesting example of how schools and businesses have used this approach to bring business people into the schools to share their expertise with students and to free teachers for professional development.

EXAMPLE

Education Development Center, Inc. - *industry volunteers in the classroom free teachers for professional development time*

In a project developed by Education Development Center, Inc., industry volunteers enabled mathematics teachers to attend a comprehensive, three-year seminar series. As a result continuous attention to professional growth was possible. Teachers were able to engage in new ideas and pedagogy, reflect on their own learning, systematically examine their practices, and explore the applications of what they were learning.

Classroom teachers left their students for specific professional development activities, while a pair of industry volunteers replaced them for 8 to 10 half days throughout the year. Industry volunteers made specific connections between their work and the classroom material, and designed original lessons that built on those connections. They taught material specified by the classroom teacher as well. Teachers and volunteers collaborated to create new lesson plans, and the volunteers took students on field trips. The industry volunteers helped students see the relevance of school subjects to the world of work, and provided role models of women and people of color in successful careers.

Companies also benefited from this experience. They received a firsthand look at the issues in education, making them more aware of the conditions of schools and the support schools need from their communities. Volunteers were afforded the opportunity to test whether teaching is a career they might consider at times of corporate "rightsizing."

This project resulted in a guidebook produced to help teachers set goals and assess their resources; recruit corporate partners and secure corporate commitment; recruit, interview, and place volunteers in the classroom; and train industry volunteers. Specific training outcomes included constructing a picture of education in today's schools, becoming familiar with the local school, learning strategies for sharing industry expertise, understanding a volunteer's responsibilities, and experiencing a positive learning environment.

Corporate partners released employee volunteers for training, classroom observation, and teaching for up to 85 hours over three years. Most companies agreed to participate with the understanding that their volunteers would not sacrifice their on-site work responsibilities.

In recent years EDC projects have provided more than 10,000 hours of professional development time for 76 mathematics teachers in elementary, middle, and high schools.

2

What new approaches to professional development, including working with industry, are being used to improve teachers' capacities?

Business and industry are valuable, sometimes untapped resources, for teachers seeking to broaden and deepen their teaching skills. Industry training departments have significant resources that provide information on industry skills and knowledge, as well as materials for technical skill development. Site visits to companies can help teachers see how their curriculum content is used in industry settings. The visits can also provide examples of problems that can be used in both academic and technical classrooms.

As teachers learn about the skills and knowledge expected of workers, they make important connections between what is expected for success at work and what is needed for teaching and learning in schools. Teachers have opportunities to explore, in depth, the ways their content is applied at work, integrated with other skills and knowledge sets, used to solve problems, and linked to higher-order thinking skills. By drawing on this knowledge for their curriculum, teachers can identify foundation skills and competencies and develop skill standards-based, real-world instructional scenarios. These experiences help teachers interact with their content in new and different ways.

Some people believe the only effective way to help teachers realize what makes up work in business and industry is to have them actually spend time working in such situations. Teacher externship programs have become popular ways to achieve a number of professional development goals, including strengthening academic content and authentic learning.

How Skill Standards Can Help

Teachers can use the skill standards as a guide to observe work in workplaces, interview frontline workers, and analyze business systems. They can make connections between "new ways of working" and how they teach in school. Seeing skill standards "in action" at work sites helps teachers develop ideas for interesting, relevant lessons and authentic assessments which integrate academic, technical, and interpersonal skills. Using the language of the skill standards helps teachers talk with employers and workers about what workers do and how work is carried out. It also helps teachers understand the culture and values of industry.

Industry skill standards provide contextual examples, or scenarios, that can help teachers learn about the types of problems successful workers are expected to be able to solve. These standards can help teachers learn about ways to integrate academic, technical, and thinking skills through problem-based learning and project activities, which help students experience a "deep learning" of academic content. Industry skill standards can help teachers develop new approaches to assessment based on how academic and technical content emerges through routine practices, problems, and challenges faced by workers.

Focusing on skill standards helps to elevate the conversation among educators and industry from more trivial issues to more substantive issues. For example, "How many job slots can my company contribute?" becomes "How will we know when student X has achieved the level of skill required by this standard?" As discussions focus on these substantive issues, each partner can see the valuable contributions of others in designing programs and activities that help students achieve success. The following examples share ways in which teachers are learning about workplace changes.

OPERATION BREAKTHROUGH!

Teachers serving as liaisons between industry and their local education system

Operation Breakthrough! in Beaumont, Texas, is a model of teacher professional development through externships in industry. It was funded by Mobil Corporation and other local businesses, and coordinated by the Beaumont Independent School District (BISD) Office of School Volunteers. The goal of Operation Breakthrough! was to create breakthrough learning experiences in mathematics and science that would help students develop the skills and knowledge needed to succeed in highly technical workplaces in and around Beaumont. BISD teachers were invited to spend six weeks in industry investigating the skills and knowledge needed for success in technical workplaces.

Teachers and their work site supervisors participated in an orientation session in which they discussed their expectations and questions about the externship. These were some of the questions: What would teachers do? How would they interact with other employees? What types of products or follow-up activities would they like to see as a result of their experience in the workplace? What company business tasks would they accomplish during the six weeks they were employed by the company?

Liaisons developed descriptions for summer jobs and interviewed, placed, and supervised teachers during their six weeks in industry. Teachers looked for ways in which their subject matter was used in industry. They were asked to document those uses and to develop problem-based lessons plans to be tried out in their classrooms during the fall. While on the job, teachers developed a project useful to both BISD and their summer employer. Combining the talents of expert frontline workers with the curriculum development and teaching skills of BISD teachers added real value for each participating company. For example:

- A middle school English teacher spent the summer interviewing workers at all levels and helped American Hydrant and Valve write ISO 9000 tasks and procedures so the company could become ISO 9000-certified;
- Two teachers helped Mobil trainers develop materials and provide workshops for frontline workers in the refinery (As a summer project one of them developed a video on the types of jobs available and the skills needed in that industry. Later, the video was used in businesses and in schools);

CASE STUDY CONT'D

- A high school science teacher worked in the laboratories at Sandoz Chemical Company conducting assays and tests while developing activities to be used in the chemistry lab.

Through these experiences, teachers gained confidence in their professional technical abilities and students learned information and skills that were connected to work in their communities. At the end of the summer, teachers participated in a debriefing and curriculum development session, in which they converted the activities they had developed into a consistent format to share among schools in BISD. Because teachers from elementary, middle, and high schools were involved, the required follow-up student projects provided a way for business and schools to work on activities that spanned grades 1-12 and many academic content areas.

In addition to these intensive teacher externships, BISD organized full-day shadowing opportunities to help teachers learn about

- the worker as a problem solver;
- how workers perform in cross-functional teams;
- quality standards;
- measurements and quality checks;
- necessary employability skills;
- the variety of occupations within the company;
- some basic principles of the workplace (e.g., safety issues, the importance of time efficiency).

From the shadowing experience, teachers were able to

- transfer what they learned at the work site into curriculum modules and lesson plans;
- present real-life scenarios as a means of instruction;
- provide employers with follow-up information;
- convey to students the business/industry perspective;
- participate in follow-up activities (e.g., field trips to the work site, guest speakers, additional shadowing experiences).

The project captured these experiences by writing a compendium of modules, which were shared across the district. (*See exhibit 6D.*) These Operation Breakthrough! activities have been sustained through the School Volunteers Program in Beaumont Public Schools. The Beaumont program is an excellent method of relaying real, industry needs to the classroom through the use of teacher liaisons.

Exhibit 6D: Internship/Shadowship Experience

OPERATION BREAKTHROUGH!! SUMMER 1994 - MATH AND SCIENCE ACTIVITIES BASED UPON INTERNSHIP/SHADOWSHIP EXPERIENCE

Math 1-6 7-8 9-12
Science 1-6 7-8 9-12

Problem/Challenge:
The Sandoz Corporation produces several agricultural chemicals. As a quality control manager you are responsible for the quality of all chemicals leaving the plant. A local soybean producer has complained of his crop dying after application of chemical A, which is herbicide, used strictly on soybeans. Chemical B is a herbicide used to eradicate all broadleaf plants and its used on coastal bermuda hay meadows for weed control. If chemical A was cross-contaminated with Chemical B it would answer the crop failure, because soybeans are a broadleaf plant. The chemical compositions are completely different and can be observed by a chemical distillation process. Your job is to find out what happened? Was there indeed cross-contamination?

Skills Focus: Analyze chemical residue, clean distillation sampling proc

Time: 1 Week

Key Questions:

What do I need to know? What do I have to do? (skills)	Who needs it (information/product) by when, in what form?	What/Who are my resources?	How do I go about getting the information I need and the tasks completed?	How should the (information/results of my work/product) be put together and presented?
· *Perform Chemical distillation* · *Chemical formulas for the two chemicals* · *Random sampling procedures - Identify plants to sample* · *Was this the only occurrence* · *Chemical analyses of sample plants* · *Chemical analyses of 2 herbicides* · *Comparison of data* Best if done as a field trip to Sandoz Lab facility	· *Plant manager* · *Lab manager* · *Lab assistants* · *Farmer* · *Written Report*	· *Lab results (quality control)* · *Manufacturing of herbicides (formulas)* · *Laboratory* · *Farmer information* · *Lab manager (to check on quality control of product)* · *Chemistry Teacher* *Agricultural Teacher* *Biology Teacher* · *Extension Agent* · *Lab Manuals*	· *Sample of plants* · *Analyze plants* · *Analyze chemicals or read formula* · *Compare result* · *Interview farmer, Sandoz corporation lab manager and lab assistant*	· *Written report* · *Charts* · *Diagram/chemical formulas* · *Oral Report*

Operation Breakthrough, Beaumont, Texas, 1994

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CASE STUDY CONT'D

Madison Park Technical Vocational High School

Using skill standards and real-life scenarios to integrate academic and technical learning

Following the principles of successful professional development listed above, the Boston Public Schools embarked on a long-term, "learning-by-doing" project. Teachers from Madison Park Technical Vocational High School learned to integrate industry and academic standards by developing *instructional scenarios*. For each scenario, a *key question* was developed to drive the integration of academic and vocational learning. The purpose was to strengthen and relate the vocational skills curriculum and the academic curriculum at the high school.

Teams of teachers selected for this project were teaching the "all-aspects-of-the-industry" course, which introduced students to the variety of vocational program choices at the school. Teachers began the integration process by reviewing skill standards for a number of industries, and aligning their vocational curriculum with both the national skill standards and City of Boston academic standards for various disciplines.

Example Alignment of National Skill Standards with Vocational Task Lists and Academic Standards

Vocational Curriculum Standards	Industry Skill Standards	Boston Academic Standards
Bioelectronics Troubleshoot DC Circuits (measure current, voltage, resistance, characteristics)	Bioscience Troubleshoot and repair equipment Instrumentation Troubleshooting ability Problem solving	10th Grade Applied Algebra Process information and communicate ideas using the language of mathematics necessary in their vocational specialty

A team of teachers reviewed how the teaching of "all aspects of the industry" could be aligned more closely with industry skill standards, the new citywide academic learning standards, and the vocational curriculum. The team determined that the ten principles of "all aspects of the industry"—technology, health, community, environment, production, career awareness, safety, management, planning, and finance—would be reinforced by using work-based problem scenarios taught in both academic and vocational classes. The solving of work-based problems helped teachers implement project-based instruction and create key questions to guide teaching practices.

During the first year, the team drafted many work-based scenarios

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addressing all ten of the principles, discussed how each would be taught, and marked the academic skills needed to solve the problems.

> Sample Draft Scenario - Year One
>
> Environment: You are an employee in the public relations office of the local electric company. The electric company wishes to promote environmentalism and conservation. Your team is in charge of writing a newsletter and producing a four-minute video to educate the public about the latest technologies, particularly that of low-wattage electric lights. For this project, use computer graphics, comparison charts, and other visual aids.

In the second year, the team used pilot scenarios in their classes and completed lesson plans. Some of the initial scenarios were then revised to better fit into the classroom environment. (*See exhibit 6E.*)

NorthWest Center for Emerging Technologies (NWCET)

In response to requests from its funder, the National Science Foundation, and intense national interest in preparing workers for information technology careers, the NorthWest Center for Emerging Technologies at Bellevue Community College in Washington State, has developed a number of "strategic partnerships" to carry out its work disseminating the information technology skill standards, related products, and services nationally.

Through one such partnership, NWCET and Education Development Center, Inc. will be providing technical assistance and support to regional training and implementation centers. These centers will respond to regional needs for education, orientation, and training related to the information technology skill standards. The centers will provide training and technical assistance in planning, professional development, and support services, including

- integration of the information technology skill standards into school-to-career and workforce development programs for in-school and out-of school youth and adults;
- regional, state, and local strategic planning to utilize the information technology skill standards in development and improvement of education-to-employment systems;
- development or enhancement of education systems that prepare people to meet both the information technology skill standards and the academic standards;

Exhibit 6E: Draft Lesson Plan

Year Two: Draft Lesson Plan - Boston Integration Project
Finance: The Great Depression and Banking

Your grandparents lost their savings in the Great Depression and, as a result, always pay for everything in cash. Since they have a high income, they can live comfortably without credit. You are the credit manager of a bank and would like to help them understand that since the 1930s, things have changed. Develop a report for them that includes the history and causes of the Great Depression. This report should include an explanation about the alterations of the United States laws after the Great Depression that have created a more stable economic environment today. Make a table that displays the positive and negative effects of using credit and show your grandparents how using credit might be beneficial to them.

Key Question: How did the Great Depression affect people's spending and saving habits?

Goals:
- understand the nature and causes of the Great Depression
- assess the advantages and disadvantages of credit card use
- investigate how to establish and maintain good credit
- apply for retail store, gas, and bank credit cards
- learn a 100 word vocabulary associated with credit and banking

Integration Subject Areas:
- banking
- math
- history
- English

Activities:
- compute bank transactions
- investigate interest rates
- calculate percentages
- interpret charts, graphs, and codes used by credit unions
- create tables and charts on the costs associated with borrowing and other bank transactions
- watch a video of credit union employees at work
- define 100 words associated with credit and banking
- review the nature and causes of the Great Depression
- job shadow a credit union employee
- study current law to reach an understanding of how government reacted to prevent a second Great Depression
- review credit application procedures used in banks, department store, and gasoline companies
- discuss the advantages and disadvantages of using credit cards and apply for them

Evaluation:
- a test on the credit vocabulary
- a test on the nature and causes of the Great Depression
- the success of the credit applications
- the quality of the charts, posters, and graphs

CASE STUDY CONT'D

- development of IT pathways which integrate academic and technical learning;
- development of a coordinated, community-based system of school and work-based education and training;
- teacher and workplace mentor development;
- analysis, to enable customization of training for particular employers;
- follow-up technical assistance to participants via phone conferences, electronic media, and written recommendations.

The NWCET-EDC strategic partnership has identified seven technical assistance and training workshop packages to help create local skill standards-based education-to-employment systems. These packages are designed to be useful to educators at various levels, within academic and technical environments, specifically targeting

- community/technical college and university faculty, and secondary technical/vocational and business education instructors who are preparing students for direct entry into information technology careers;
- educators and employers developing school-to-career programs and systems;
- secondary academic teachers whose curriculum requires students to use technology skills, tools, and resources to achieve academic standards;
- policy developers and practitioners creating strategic plans to reform education and/or employment systems, designing systems, and allocating resources;
- academic faculty who are integrating IT skills and knowledge into their programs and curricula;
- counselors who are assisting students in their career development;
- computer literacy teachers;
- elementary and middle school teachers using technology as a tool for instruction.

EXAMPLE

Boston University Medical School, CityLab Program - *teachers developing skills along with their students*

Boston University Medical School's CityLab Program provides teachers an opportunity to develop skills and update their knowledge of bioscience techniques. Educators and students within the region participate in activities in a fully equipped bioscience DNA laboratory. To prepare for their classes' visits to CityLab, teachers must take part in an orientation workshop, where they are guided into discovery-oriented methods, curriculum, technology, and resources. Teachers visit CityLab four to five times during the school year with different groups of students.

At first guided by CityLab staff, teachers become more independent in each subsequent visit to the lab, as they grow more familiar with the content, knowledge, and techniques. Teachers' levels of comfort also increase as they gain more experience in the laboratory setting. By the end of the experience, many teachers have the baseline of experience and ability needed to teach biotechnology on their own. Repeated exposure to biotechnology in a nonthreatening atmosphere is of greater value in helping teachers move into this new arena than are single workshops. Teachers can work along with their students, gaining confidence in their newfound content and laboratory skills. CityLab's staff view teachers and students through the same lens: as individuals who are new to the world of biotechnology and building an initial set of biotechnology experiences. In this way, professional development and student learning are the same.

At its satellite sites, CityLab partners with scientists and teachers. Scientists can see what high school teachers do and the challenges that teachers face. Teachers work with a scientist and exchange ideas to understand what scientists do. This combination of a specialist in pedagogy and a specialist in science content empowers both the teachers and the scientists. This exchange is especially helpful to those scientists who may not have been trained as educators, but who are required to teach others as part of their work assignments.

EXAMPLE

California Foundation for Agriculture in the Classroom (CFAITC) - *school-based "ambassadors" provide support to educators integrating agriculture into the classroom*

The California Foundation for Agriculture in the Classroom (CFAITC) has designed a program that teaches the importance and benefits of agriculture for everyone, with a goal of reaching every California child. The foundation was established as a nonprofit in 1986. It creates programs that help teachers use agriculture as real-world themes with hands-on examples. Math, social studies, language arts, science, and fine arts are all taught using agriculture. The foundation emphasizes the direct link between the nation's high standard of living and its strong agricultural history.

CFAITC has developed an Ambassador Program that has established a network of educators interested in incorporating agriculture into classroom curriculum. Ambassadors receive 3 to 5 packets a year containing newsletters, commodity fact sheets, and other related information. One ambassador at each school serves as a liaison and helps the foundation by distributing additional copies of the materials to colleagues.

Also available to all teachers are a number of free materials which contain rich sources of ideas for the classroom teacher; for example:

- a subscription to Cream of the Crop Newsletter, which highlights teachers statewide who use the agriculture classroom activities (*see exhibit 6F)*;
- a teacher resource guide that lists free and low-cost materials and projects;
- a lesson plan booklet of inexpensive educational lessons and units that correlate to the California frameworks for public schools, to integrate agriculture into science, mathematics, social science, language arts, and other curricular areas;
- a project idea sheet that displays simple ways to integrate agriculture into any

Exhibit 6F: Cream of the Crop Newsletter

■ CALIFORNIA FOUNDATION FOR AGRICULTURE IN THE CLASSROOM ■

Cream of the Crop

A Harvest of Ideas for Educators Vol. 13, No. 1 Autumn, 1999

Inside

■ 2 - 3 ■
Applications due Jan. 15 for Summer Ag Institute

■ 4 - 5 ■
Farm-City Week binds rural to urban

■ 6 ■
California Heartland – field trips minus the bus

■ 7 ■
Resources! Resources!

■ 8 ■
Let the *Imagine this...* writing contest begin!

California Foundation For Agriculture In The Classroom

Gardens require planning, money to successfully grow

Pull out the shovels – it's time to start digging. State Superintendent Delaine Eastin set a goal in 1996 for "a garden in every school" by the year 2000. That means this fall it's high time to get growing!

Before the dirt starts flying, however, take time to plan and to raise necessary funds.

For the planning component, start by contacting the Nutrition Services Division of the state's Department of Education (916/ 322-4792). It offers free of charge to California teachers "A Garden In Every School," a must-have comprehensive packet of school gardening how-to's. Contents include information about gardens and nutrition; suggestions for books, resources and supplies; listings of pertinent websites; a vermicomposting guide; garden publication addresses; Food Guide Pyramid poster; and guidelines for financial assistance.

That's an important detail, because money doesn't grow

See *Gardens*, page 6

Gardens have become increasingly popular with educators as a way to integrate agricultural awareness into their curriculum.

Confer in Ventura!

The coast should be clear this fall, but a guaranteed tidal wave of resources and ideas is forecast to sweep educators *into* Ventura for the annual California Conference for Agriculture in the Classroom Oct. 14 - 16.

Registration is due Oct. 1.

The polychromatic mosaic of Ventura County agriculture blended with the coastal setting makes an ideal site for the conference. "It enhances our goal – to enrich educators' abilities to teach students why agriculture is still so important

See *Conference*, page 6

Money doesn't grow on trees – not even on school garden varieties.

school/classroom;

- *Ambassador Update,* a publication that includes updates on new lesson plans, classroom ideas, resources, and free promotions;
- invitations to training workshops and services.

CFAITC also offers a summer program through SAI (Summer Agricultural Institute) that provides a five-day seminar for California educators, from kindergarten through college. The seminar focuses on food and fiber production, and how to incorporate that agricultural information into existing classroom curriculum. SAI provides hands-on learning with practical curriculum development and implementation. Thirty applicants are chosen to participate. Credits can be earned through California State University at Chico.

EXAMPLE

Access Excellence - *using the information highway to build innovation and seek out support for teaching and learning practices*

Access Excellence, funded by sole sponsor Genentech, Inc., was launched in 1993. Access Excellence is a national educational program that provides high school biology teachers access to their colleagues, scientists, and critical sources of new scientific information via the Internet. The program provides a computer network forum through which teachers can share their innovative teaching ideas and activities, and access information, expert assistance, the advice and experience of other teachers to create ideas, and best practices. On the Internet, teachers find Access Excellence lesson plans, a virtual library and clearinghouse of related materials produced by national and local organizations, a Vanguard Science Speaker's Forum that provides them the opportunity for Q&A sessions with renowned scientists, and access to "What's Hot" as well as a suggestion box. For each of the past three years, the National Science Teachers Association has chosen 100 fellows, representing every state and Puerto Rico, to help design the program and online forum. There are currently 310 fellows. Access Excellence is an excellent example of a national network to assist communication among teacher colleagues and with industry to help educators increase their knowledge and awareness. (*See exhibit 6G.*)

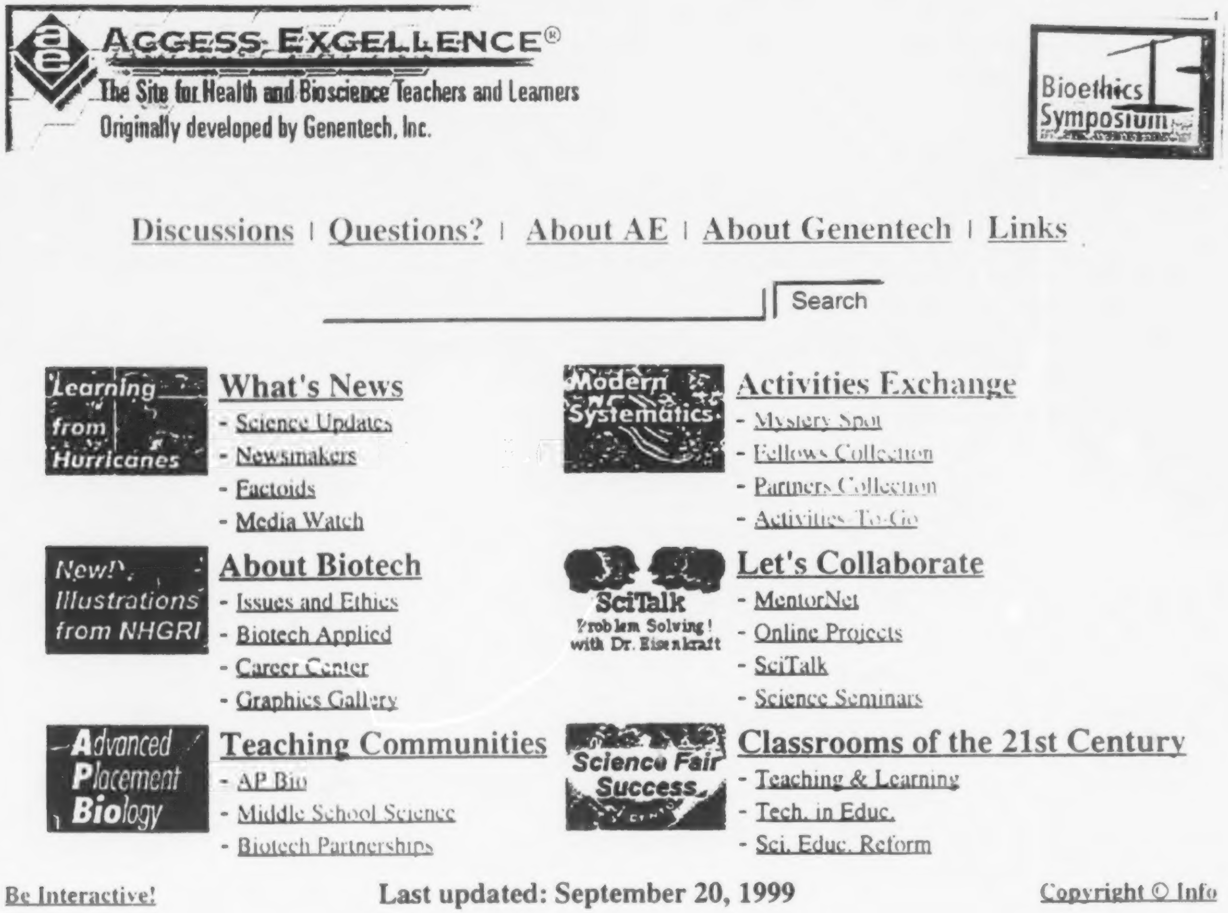
EXAMPLE

East Cleveland Public Schools - *elementary school science teachers explore their role in developing core skills needed in the bioscience industry*

As part of East Cleveland's UROG (School-to-Work Urban-Rural Opportunities Grant) Project, science teachers from East Cleveland's grade 1–12 classrooms explored their role in preparing students in the fundamentals needed for scientific and technical careers. With guidance from Education Development Center, teachers reviewed industry skill standards as a way to think about the foundation skills needed to support a bioscience career pathway. They participated in discussions about current trends in the bioscience industry and discussed the relationship of education to economic development. Teachers made use of the skill standards in their curricula, correlating the standards with the foundation skills commonly taught as part of the science program. They considered the following questions:

- What duties, tasks, industry skills and knowledge, and behavioral attributes were

Exhibit 6G: Access Excellence Web Site Menu



ACCESS EXCELLENCE®
The Site for Health and Bioscience Teachers and Learners
Originally developed by Genentech, Inc.

Discussions | Questions? | About AE | About Genentech | Links

What's News
- Science Updates
- Newsmakers
- Factoids
- Media Watch

Activities Exchange
- Mystery Spot
- Fellows Collection
- Partners Collection
- Activities To-Go

About Biotech
- Issues and Ethics
- Biotech Applied
- Career Center
- Graphics Gallery

Let's Collaborate
- MentorNet
- Online Projects
- SciTalk
- Science Seminars

Teaching Communities
- AP Bio
- Middle School Science
- Biotech Partnerships

Classrooms of the 21st Century
- Teaching & Learning
- Tech. in Educ.
- Sci. Educ. Reform

Be Interactive!

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already included (although in an elementary way) in their curricula? In other words, what was already there?

- What did they want to include more of to prepare students for a bioscience career pathway?

Although this process has been used as part of a "gap analysis" for programs leading to immediate employment in an industry, the unique feature of this exercise was that it asked these questions of *elementary school science teachers*. The following table shows the relationship between the tasks of a Bioscience Technical Specialist I and science activities in grade 2. In column 1, teachers listed the tasks as they appeared in the national skill standards for the bioscience industry. Teachers marked an X in column 2 if this task was performed in their curriculum (Note: in some cases, teachers performed the task in preparation for an activity. In other cases, students performed the tasks in a very elementary way.) Teachers suggested that students perform some of the preparation tasks as part of their learning. This was clearly an interest of high school teachers who saw an immediate value in having students develop bioscience laboratory skills. Teachers used column 3 to indicate how they implemented this task, and what existing science curriculum activity contained that task. Teachers marked column 4 with an X if they wanted to add this task to their curriculum, or emphasize it more.

Tasks	**Do**	**How**	**To Add**
A-1 Obtain and read protocol, test procedure, SOP	X	Experiments	
B-1 Follow SOP, and batch record (protocol or procedure)	X	Cooking	
B-2 Obtain raw material	X	Want to develop plant sales, do more quality control, recycle (recover products)	X
B-4 Perform cleaning (manual/CIP) and sterilize (autoclave/SIP)	X	Clean	
C-4 Obtain and label sample/specimen	X	Label	
E-2 Order supplies, reagents, animals	X	Order moths	

This example illustrates that teachers at all levels can reexamine their curricula through the lens of skill standards, to find the connections between what they teach in school and what skills and knowledge will be required of students when they enter the workforce.

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Conclusion

Recent changes in work have required us to rethink the professional development experiences we use to guide our educators in learning new content, teaching methodologies, and assessment practices. Vocational programs have been working to meet these needs by developing applied academics programs and supporting new models that integrate academic and vocational learning. Education-to-employment programs, as well as most education reform initiatives, are incorporating problem solving, performance-based learning, and competency-based assessment models. The academic community, slow to change in response to workplace needs, is beginning to integrate more technical concepts and skills into programs and curricula.

Skill standards help educators deal with these professional development challenges in the following ways:

- Learning about industry skill standards and seeing them "in action" at work sites, helps teachers deepen their understanding of what current and future technical workers need to know and be able to do to succeed at work. The clarity of this image helps them make the important connections between the content of what they teach and their students' future applications of that content;
- Using the skill standards as a guide, teachers can make connections between new ways of working that characterize modern enterprises and the ways they teach in school;
- Being able to engage in the common language of the skill standards with frontline workers helps students sustain partnerships and allows them to participate in over time continuous learning.

We live and work in a time of significant technological change. This has made an impact on what we need to learn, how we need to learn, and where we need to learn. There is an emerging awareness of the need for a more "balanced" (technical and academic) curriculum for all students. This generates a heightened realization about the importance of and urgency for useful and effective professional development activities that support educators implementing skill standards.

Using Assessment Methods

This section provides examples of how various education and employment stakeholders have dealt with the issue of assessment in programs preparing people for work. Most examples are drawn from sites which are implementing skill standards-based curriculum, or are using skill standards as part of their assessment. Topics addressed in this section cover some of the major issues related to assessment in schools and workplaces: performance criteria, assessment methods and their components (such as scoring rubrics), and learner assessment.

Key Questions

1. What is skill standards-based assessment, and why and how is it used?
2. How can mastery of both individual tasks and skills and complex learning in real-life contexts be assessed?

1 What Is Skill Standards-Based Assessment, and Why and How Is It Used?

Assessment is a general term referring to the many ways teachers and workplace supervisors collect and evaluate information used to measure student progress. Assessment measures a student's mastery of knowledge, required skills, and required behaviors. There are several common types of assessment: (a) performance measured against an established standard (criterion-referenced); (b) performance of one individual against other individuals in a group (norm-referenced); and (c) a group's performance measured against other groups. Assessment also provides information to determine the effectiveness of education and training programs.

How Skill Standards Can Help

Skill standards provide test developers with specific information – tasks, knowledge, and behavioral attributes, as well as required competency levels – to develop assessment tools and measurement rubrics for work-related learning. Competency-based education (CBE) and training programs based on skill standards (reflecting what workers need to know and be able to do to succeed on the job) ensure that curriculum, instructional materials, and correlated assessments reflect the skill and knowledge requirements for current and future workers. The component parts of skill standards can be used to develop written and performance tests. Scenarios, found in many skill standards, can illustrate the ways in which skills and knowledge are embedded in authentic, real-life/work situations. Scoring rubrics can be developed to measure the degree of mastery of the component parts of skill standards. They also can be used to demonstrate the student's ability to integrate those components when performing a complex task or solving a problem.

Assessment Approaches

Programs that prepare people for work include a variety of assessments that evaluate or measure program effectiveness, and determine a student's course progress. The following examples present approaches and techniques that programs developed using standards-based assessment.

MiraCosta College - *assessing employer satisfaction with graduates and the instructional program*

The assessment method used at MiraCosta College, in Oceanside, California, evaluates both the quality and usefulness of its Biotechnology Certificate Program for employers, as well as the knowledge and progress of the program's graduates. This two-part assessment begins with an initial questionnaire for graduates and employers, given immediately following graduation. (*See exhibit 7A.*) One year later graduate and employer follow-up surveys are sent to employers in the area (e.g., Nanogen, NOVEX, Houghten Pharmaceuticals, and Advanced Tissue Sciences). The purpose of the questionnaires is to determine whether the training provided at the school is meeting the needs of both students and industry. The survey provides the school with important information for revising the program, if necessary, to better meet industry needs. It also asks what recommendations graduates have for better preparing current students to enter the working world. This feedback provides additional value by tracking the progress of MiraCosta graduates.

Nekton/Norhaven - *performance-based contracting for intermediate care facilities for persons with developmental disabilities or related conditions*

Nekton and Norhaven, private, for-profit direct care organizations, in Minneapolis, were selected by the Minnesota Department of Human Services to be part of a three-year demonstration project to improve services for people with mental retardation or related conditions. This project was part of an effort to allow clients the opportunity to send a direct message to service providers about their needs. To do this, Nekton/Norhaven integrated the human service skill standards into their demonstration project. These skill standards organized job responsibilities of direct care workers around competency areas such as "community and service networking;" "vocational, educational, and career support;" and "participant empowerment." This initiative helped define the philosophical shift from a focus on *program* needs to a focus on the *individual being served*. It also helped the organizations' workers develop the skills and knowledge needed to make these changes and implement their outcome-based approach. Several of the main training courses for

Exhibit 7A: Initial Employer Questionnaire

MIRACOSTA COLLEGE BIOTECHNOLOGY CERTIFICATE PROGRAM

Initial Graduate Questionnaire

This information is being requested to assist MiraCosta College in tracking the progress of graduates of the MiraCosta College Biotechnology Certificate Program. Disclosure of any information by you is entirely voluntary. The information will be used to assess the efficacy of the training such that the needs of both students and industry can be better met. Except for those purposes, this information will not be disclosed or disseminated in any manner except as part of statistical reports, or in a form which would not allow identification of individuals or companies. This initial questionnaire will be followed within one year by a subsequent questionnaire to asses your progress.

* * *

INFORMATION

Name

Employer

How long did you look for a job before being hired here?

How many applications or resumes did you sent out?

How many interviews were you granted?

Job title

Summary of job responsibilities

How many hours per week do you work?

What hours of the day/night?

What is your salary?

Do you intend to go on to get a bachelor's degree?

In what field?

Date

Signature

(continued exhibit 7A)

Are you familiar with the MiraCosta College Biotechnology Certificate Program?______________

Would you like more information about the program?__________

How many job openings do you estimate your company will have in the next year that would be suitable for graduates of this program?_____________

______________________________ By: ______________________________

Company Name

Signature

____

Typed/Printed Name

____

Date

____

Title

employees were modified to fit competency areas identified in the human services skill standards. In addition, Nekton and Norhaven identified skill standards for all their direct service providers; these included knowledge, skills, competencies, and performance measures.

EXAMPLE

Human Services Research Institute, Inc. (HSRI) - *assessment techniques used in the field test of community support skill standards*

Assessment of student mastery of skill standards is possible with many traditional techniques and methods. During the field testing of the human services community support skill standards, community college instructors and work site supervisors identified the wide range of assessment methods they used while field testing the skill standards. These included many of the common assessment methods found in most classrooms:

- Written tests, with multiple choice or true-false answers;
- Tests with open-ended questions related to readings, class discussions, or fieldwork concerning important issues;
- Pre- and post-course tests to measure mastery of course objectives;
- Clearly developed performance indicators specific to student experience which measure mastery of competencies;
- Take-home written tests;
- Reviewing ongoing journal entries;
- Having students, as a group, prepare and present a case study and discuss how to deal with it;
- Having students write an opinion paper, based on an article, video, film, Internet discussion group, or book that raises an issue related to the skill standards content;
- Having students write a discussion paper based on a field-trip experience, or real work experience related to a particular skill standard content issue;
- Group discussions around real-life vignettes presented in class;
- Using portfolios to collect various documents that indicate students' achievements over time (e.g., letters or recommendations by supervisors, courses, workshops, seminars; participation in career-related activities; other personal achievements; letters from consumers, parents);
- Having students write up their own case studies or scenarios to illustrate key issues in their work then discuss how they would handle them
- Having students assess the existing barriers to doing their jobs and the changes needed to overcome them;
- Having students give an oral or written account of their own work with a disabled person, and how they (the worker) dealt with the situation;
- Having students critique a team meeting or case review session they attend and discuss issues related to content of skill standards.

Many of these traditional methods help provide a rich and comprehensive evaluation of the students' accomplishments as they work to develop skills and knowledge needed in industry.

Education Development Center, Inc. (EDC) - *using a variety of assessment methods to evaluate mastery of skills and knowledge in real-world contexts*

Education Development Center, Inc. worked with bioscience educators and industry managers and workers to identify a variety of assessment methods appropriate for these scenario-based skill standards. Developers of the bioscience skill standards suggest that teachers do the following:

- Evaluate work-based performance of procedures or problem responses to determine if appropriate and complete actions are taken;
- Evaluate performance in classroom settings through role play, computer-based simulation, or other performance-based techniques to determine if appropriate and complete actions are taken;
- Review the actual result of process (sample, equipment, facility, material, parameters, product, document) to see that the person correctly performed the procedure;
- Review written documentation (e.g., reports, exams) for accuracy and completeness;
- Evaluate verbal presentation for accuracy and demonstration of mastery;
- Conduct mock situational (scenario-based) interviews to assess mastery;
- Evaluate documents or exhibits collected in portfolios to determine how well they demonstrate mastery;
- Have people critique their own or a peer's journal, other materials, and performances for accuracy and completeness;
- Examine reviews or assessments of person, procedure, or document audit made by others (supervisors, mentors, colleagues, clients);
- Have other people reproduce activities (procedures, problem responses, etc.), following peers' journals, documentation, procedure descriptions, and reports to see if the entries are correct and clear.

Although developed for the bioscience industry, these methods are adaptable to other industries and their education and training programs to evaluate mastery of skills and knowledge in real-world contexts.

New Hampshire Community Technical College (NHCTC) - *assessing student progress through course work and determining grades*

Converting progress in developing skills to a grading system has its unique set of challenges. The NHCTC Center for Biotechnology Education and Training in Portsmouth, New Hampshire, has developed a system of points that determine the grade students receive for each course. At the beginning of the program, students are presented with guidelines which detail the numbers of points associated with each deliverable in their biotechnology course. (*See exhibit 7B.*) Point systems similar to this one used at NHCTC biotechnology program help convert the attainment of skills and knowledge into grades that quantify achievement levels at community and technical colleges.

Exhibit 7B: Biotechnology Experience Research

Assessment

A single grade will be given for the course. The grade will consist of three parts:

Skills Assessment: Attached to this syllabus will be found a sheet indicating the training elements, bioscience skills, criteria for assessment of the skills, date due, method of assessment, and numerical value of each method of assessment. If one achieves the maximum value for each assessment criterion, one will gain 100 points. This part of the assessment (grade) is worth 75%.

Knowledge Assessment. Your knowledge of the "Cental Dogma" of biology and how this plays out in the field of biotechnology research will be assessed in an early final exam. This knowledge assessment is worth 20%.

Attributes Assessment. Up to 1 point each (5 points total) will be given for documentation of 5 of the 36 attributes recommended for bioscience technicians. One of these documented attributes must be reliability (for our purposes the assessment for reliability will be attendance at all labs and lectures). This attributes assessment is worth 5%.

Extra Credit. An additional 5 points can be added to your total grade by documentation of the following skills not addressed in the 100 point skills assessment, above. E2 Order supplies, reagents, animals; E4 Verify incoming delivery accuracy; E5 Check expiration dates and lot numbers; F5 Sample environment; F8 Trouble shoot and repair eequipment; I1 Inspect, release incoming inventory; K4 Write memos and letters; L1 Assist with design of research protocol; N3 Participate in continuing education and professional organizations; N7 Promote community education.

Laboratory Notebook. Students must keep a laboratory notebook which will be a record of their journey through the course. The laboratory notebooks will be examined for specific documentation required for the course grade.

Human Services Program at NHCTC - *students take responsibility for learning through self-assessment of progress in mastering skill standards*

As part of one human services course in Berlin, New Hampshire, students were asked to report their changing levels of skill mastery by describing ways they gained proficiency in carrying out work responsibilities in internships and on the job. Students were required to complete and submit a form, as part of their course evaluation. This self-reporting complemented the teacher's site visits, observations, and supervisor reports. To report on their own skill development, students need to understand the skill standard, determine how and where it appears in real work situations, and assess their own specific skill mastery. The effect of the self-reporting was a subtle but distinct shift in the "teaching-learning balance" of the course, from one in which the teacher was responsible for teaching to one in which the students were responsible for learning.

North Seattle Community College - *a five-part assessment plan that weaves together curriculum development and implementation of the American Electronics Association skill standards*

North Seattle Community College, using funding from the National Science Foundation, found themselves on a fast track to implementing skill standards within their electronics programs. Because the standards were new and the curriculum based on those standards was not yet available, the college developed an assessment plan that contains continuous feedback loops to be useful during simultaneous curriculum development and program implementation processes. This assessment model distinguishes between specific technical content, nontechnical processes, and larger projects and tasks. (*See exhibit 7C.*)

The North Seattle Community College assessment model has three major components:

1. *Tasks* (activities that students engage in require the use of technical and nontechnical skills and knowledge) which can be small, focusing on a single technical topic, or large, requiring the students to draw knowledge and skills from several courses;
2. *Assessment medium* which defines the ways information is gathered and simply records results;
3. *Assessment tools* which are used to measure students' performance against the desired performance indicator of criteria.

These three parts, in combination, describe how the assessment process is carried out in five steps:

Step 1: Identify performance indicators or criteria for technical content and nontechnical content items. Overlay the nontechnical skills on the program grid.

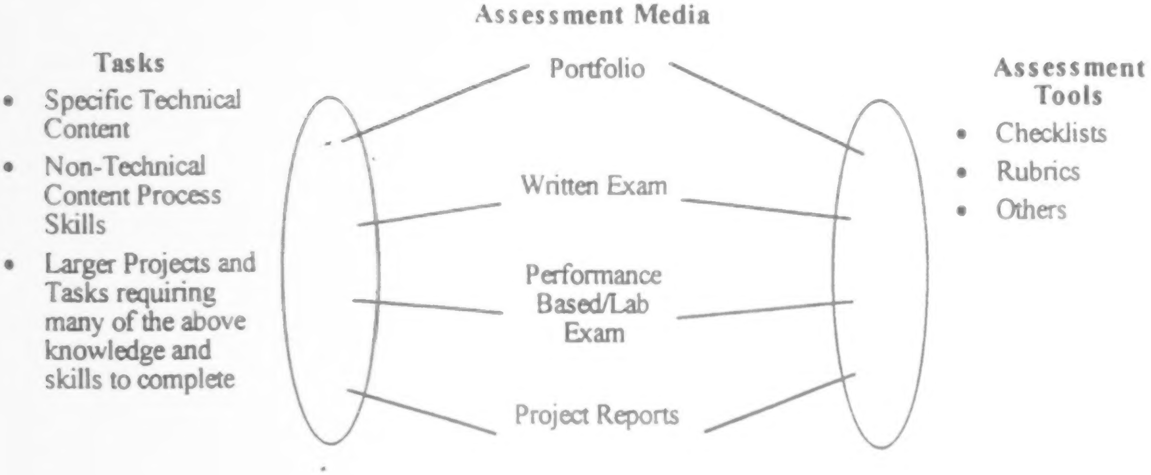
Step 2: Provide tool-use training for faculty (rubric and observation checklists).

Step 3: Produce assessment pieces that apply the tools to a variety of media (e.g., portfolios, capstone project, scenarios, lab/performance-based tasks).

Step 4: Identify and establish a mechanism to track student progress.

Step 5: Evaluate both the courses and the programs.

Exhibit 7C: Continuous Feedback Model


Assessment Media
Portfolio
Written Exam
Performance Based/Lab Exam
Project Reports
Tasks
Specific Technical Content
Non-Technical Content Process Skills
Larger Projects and Tasks requiring many of the above knowledge and skills to complete
Assessment Tools
Checklists
Rubrics
Others

In considering assessment, it is necessary to clearly distinguish between the Task, the Assessment Media, and the Assessment Tool.

- Task: An activity the student engages in that requires the use of knowledge and skills, both technical and non-technical.
- Assessment medium: This is the medium used to gather the information that is to be used with the assessment tool. Such things as portfolios, pencil and paper exams, journals, project reports, performance based (lab) exams are examples of assessment media.
- Assessment tool: Such things as observation checklists or rubrics are used to identify whether the learner has met the performance indicator/criteria or not.

The diagram above shows graphically how these three items relate to the assessment of a task.

- The student does a task. The task can be a small one concentrating on a single technical topic or process skill. The task may be a larger one requiring that the student use skills from a number of different courses or topics.
- The assessment medium is chosen. The assessment medium simply allows the recording of the task results. The recording may be in the form of an observation as in the performance of a lab, it may be the preparation of a portfolio piece or an oral presentation. This is the "record" that will be accessed with the assessment tool.
- The assessment tool is chosen and used to observe the product recorded in the assessment medium. The assessment tool is the instrument through which the observer can assess the task as recorded. The assessment tool allows the user to observe the record of the task against performance indicators or criteria. This comparison becomes the assessment record.

Therefore, in planning for assessment, it is necessary to have ready a number of assessment tools and assessment media. In selecting the tools and media, one must make sure that selections are available to cover all three task categories as illustrated above. Having the tools

EXAMPLE

American Chemical Society (ACS) - *using skill standards to structure assessments for programs seeking approval from an accrediting body*

The ACS developed skill standards for two occupations important to the chemical process industry: chemical laboratory technician and process technical operator. The Gap Analysis tool developed during this project (and presented in the Creating Curriculum section) contains the 114 performance criteria identified in the chemical industry's skill standards project. The educational institution portion of the gap analysis was completed by faculty at schools petitioning Chemical Technician Program Approval Service (CTPAS) for program approval. In this self-assessment, faculty rated the degree to which each of the performance criteria were present in a school's curriculum on the following four point scale: "0" = Not Present, "1" = Introduced, "2" = Practiced, "3" = Mastered. This faculty self-assessment was incorporated into the CTPAS program approval process. When compared against responses from industry on a similar rating scale, the assessment identified the "gap." This tool then became a mechanism for alliances between education institutions and local industry to develop curriculum and learning experiences that help close the skills gap between schools and work. This program self-assessment tool adds value to the skill standards and school-to-career movement. It is an important tool for gathering and assessing information as alliances structure pathways from school-to-career in any industry.

EXAMPLE

Indiana Essential Skills and Technical Proficiencies Initiative - *scenario-based assessment and certification*

Indiana students share information about the assessment of their competencies, transferable across various occupations, through a portfolio of skills called a Certification Notebook. These competencies describe the students' achievements in developing interpersonal skills and in working with resources, technology systems, and information. Their development of basic skills such as mathematics, reading, speaking, decision making, and problem solving is also captured. The Certification Notebook includes the following:

- An open letter to prospective employers and postsecondary admissions counselors, describing what the notebook contains;
- Certificate(s) of technical achievement earned by the students and signed by the Governor of Indiana;
- A listing of the technical proficiencies obtained;
- An evaluation report which shares students' assessment results in their areas of technical proficiency. (*See exhibit 7D.*)

EXAMPLE

Project SMART - *defining performance criteria based on skill standards*

Because teachers and frontline workers sometimes use language differently, developers of Project SMART (School for Manufacturing and Related Technologies) in Cleveland, Ohio, teamed with frontline workers to help facilitate communication as they developed curriculum and constructed assessments. They defined performance criteria for each of the tasks identified through the use of a DACUM job analysis for manufacturing technicians. Next, frontline workers were asked to list how they would indicate that a specific task was

Exhibit 7D: Certification Notebook

INDIANA ESSENTIAL SKILLS AND TECHNICAL PROFICIENCIES INITIATIVE

CERTIFICATION NOTEBOOK

To my prospective employer or postsecondary admissions counselor:

This Certification Notebook has been assembled to show you what I **know and can do**. On the following pages you will find my Indiana Certificate of Technical Achievement which documents the knowledge and skills I have acquired in the area of Plastics. Following the Certificate is backup information which details the performance-based assessment process I completed to receive the Certificate.

Also included in the information is an assessment of my competencies that may be transferable across various occupations, such as interpersonal skills and working with resources, technology, systems, and information. When appropriate, assessment information on my basic and thinking skills such as mathematics, reading, speaking, decision making, and problem solving is also included.

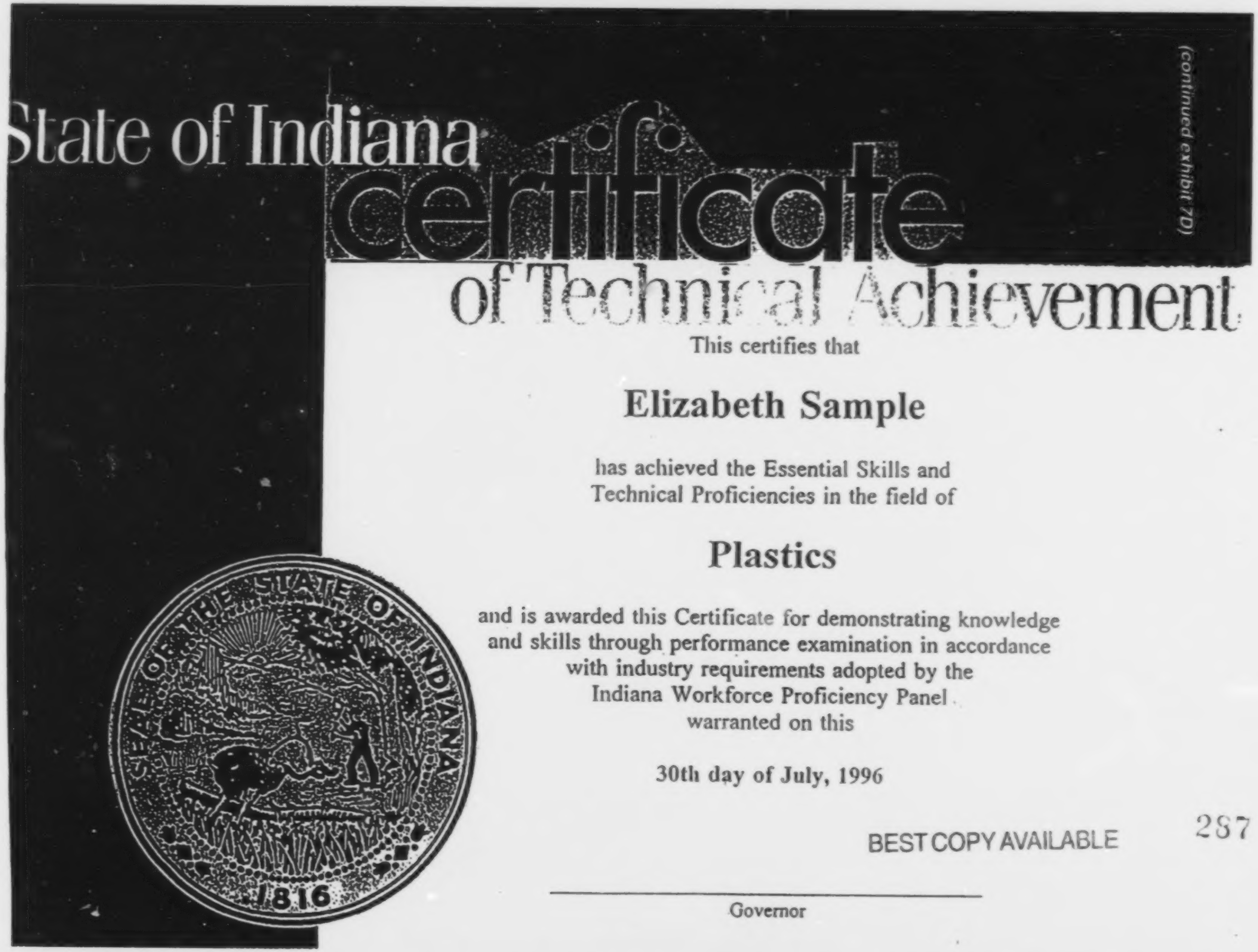
I am prepared to discuss my experience and skills with you in more detail. Thank you for the opportunity to show you what I **know and can do**. For more information on Indiana's statewide Essential Skills and Technical Proficiencies Initiative or the state-endorsed Certificates of Technical Achievement, please contact the Indiana Department of Workforce Development at (317)232-1820.

Sincerely,

Elizabeth Sample

Elizabeth Sample

(continued exhibit 7D)



State of Indiana certificate of Technical Achievement

This certifies that

Elizabeth Sample

has achieved the Essential Skills and
Technical Proficiencies in the field of

Plastics

and is awarded this Certificate for demonstrating knowledge
and skills through performance examination in accordance
with industry requirements adopted by the
Indiana Workforce Proficiency Panel
warranted on this

30th day of July, 1996

Governor

1816

BEST COPY AVAILABLE

performed well, and how they would know when there was failure to master a task. In some cases, indicators of mastery and failure to master were simple opposites of the same continuum. For example:

Task: Produce Set-up Sheets

Indicator of Failure to Master		Indicator of Mastery
Actual time required for each operation diverges greatly from estimated time required for each operation and/or actual times are not recorded	1 2 3 4 5	Accurately estimates actual time required for each operation; lists on sheet

In other cases, the indicator of mastery and failure to master were opposites, but included more than one possible cause for failure. For example:

Task: Produce Set-up Sheets

Indicator of Failure to Master		Indicator of Mastery
Cannot/does not retrieve information on demand	1 2 3 4 5	Retrieves information on demand

This second example indicates either an inability or an unwillingness to accomplish the task. In either case, it is useful because these indicators of mastery and failure to master were identified by frontline workers in manufacturing and reflect the ways workers are held accountable for these tasks on the job.

The process of asking frontline workers to identify these indicators as they would be measured in the workplace was valuable. It added performance indicators which might not have been listed by academic educators. For example, when educators think about the task "use listening skills," they might not consider the cause "machines not running well." Identifying this cause of failure to master listening skills in the manufacturing workplace was essential to both the safety and the success of frontline workers.

Competency-Based Assessments

How do we assess specific technical skills and knowledge? Many programs integrating skill standards are using competency-based forms of learning and assessment which have their roots in the work of vocational educators of the 1960s and '70s. CBVE (Competency-Based Vocational Education) organizes student learning around modules that allow students to take performance and knowledge tests and gain credit for previous learning or experience.

Within this system of vocational training, each self-paced, individualized module usually contains a knowledge (written) test, a performance test, and a competency checklist (the instructor checks off a student's specific achievement of each competency or standard). Records are kept to track individual and group progress across the bank of modules. Elaborate formulas convert the individual learner's progress to a grade, based on the average time it takes to successfully complete modules. For many vocational or technical educators today, this type of competency-based training system is the basis for assessments that demonstrate mastery of skill standards.

Within the structure of CBVE, performance tests based on skill standards can play a critical role in assessing students' level of mastery. Developing good performance tests challenges many educators and trainers. The following case study and example include a performance test which can be used by assessors as a self-check.

CASE STUDY

NorthWest Center for Emerging Technologies (NWCET)

Competency-based assessments for information technology skill standards

The Curriculum Development Kit (CDK) is a guidebook for educators wishing to develop or implement skill standards-based curriculum. It builds on the previous work of NWCET, a center for the improvement of advanced technology education in information technology at Bellevue Community College, Bellevue, Washington. The CDK helps translate information technology skill standards into competency-based curriculum for new and existing programs. In addition to curriculum development resources, the CDK contains an overview of performance-based assessment informed by skill standards. It includes the following:

- Basic assessment definitions;
- An overview of shifts in assessment research and applications;
- A discussion of the relationship between outcomes, learning activities, and assessment;
- Examples of traditional and alternative assessments;
- Key questions in thinking about effective assessment.

The CDK also contains tools for developing assessments and other tools useful to faculty:

- A step-by-step process to align curriculum and assessment;
- A checklist for making assessment strategy decisions;
- Characteristics of authentic assessments;
- Questions for reviewing your evaluation methods and instruments;
- Questions to consider while writing or reviewing course outlines;
- Ways to think about assessment strategies;
- Seven common types of performance assessments;
- A menu of products and performances;

- Rubrics;
- Student reflections through self-assessment;
- Sample assessments as they are included in self-assessments, portfolios, and capstone projects.

These assessment resources support a curriculum development process that draws skill standards into programs and courses through a model incorporating both technical learning components (broad skills and knowledge topics such as business knowledge, computer history, and content; Internet resources, spreadsheet, or word processing); foundation learning components (e.g., analysis, customer relations, problem solving, or project management); learner program outcomes which are broad goals supporting the learning components; and key competencies and performance indicators which support the learner program outcomes.

Although specifically designed to assist faculty in assessing student progress in developing mastery of information technology skill standards, the model curriculum products and process as well as the assessment techniques and practices in the CDK constitute a comprehensive set of resources geared to faculty developing assessments based on skill standards for any industry.

EXAMPLE

University of South Florida - *developing performance tests*

Performance tests are commonly used to test mastery of skills. The *Handbook for Developing Competency-Based Training Programs* (Blank, 1982) tells us that performance tests assist instructors in many ways. It helps them judge whether or not the student can actually perform the task in a job-like setting to some minimum level of acceptability, and lists the following steps for developing a performance test:

Step 1: Determine exactly what should be tested (task mastery, knowledge, attributes).

Step 2: Determine whether process, product, or both is critical (process is how the student performs the task, product is the end result).

Step 3: Construct the items to be included on the test.

Step 4: Determine how the items are rated.

Step 5: Determine the minimum acceptable score for mastery (*see exhibit 7E*).

Exhibit 7E: Performance Test For Developing a Performance Test

Directions

When ready, demonstrate your ability to develop performance tests by doing the following:

For tasks for which Terminal Performance Objectives (TPOs) and task analyses have been developed:
1. Develop performance tests.
2. Try out performance tests and revise.

Criteria for evaluating performance; 100% mastery YES NO

Directions
1. Are the directions clear and concise?
2. Is the purpose of the test mentioned?
3. Is the testing situation described for the student?
4. Is the student told exactly what to do?
5. Are any special restrictions mentioned?
6. Is any time limit mentioned?

Test Items Relating to Process
7. Are process items included if the process is important for competence on the job?
8. Are only critical process items included?
9. Do items begin with a verb in the *past* tense?
10. Are items based on the procedural steps in the task analysis?
11. Is each item objective and observable?
12. Can each be rated *yes* or *no* and worded so that *yes* is the desired response?
13. Are words such as "good" and "well" avoided?
14. Is only one step included per item?
15. Are subitems used if needed?
16. Are items listed in the order in which they occur?

Items Relating to Product
17. Are product-related items included if the quality of a finished product is critical for competence?
18. Are only critical characteristics of the finished product included?
19. Do test items begin with a verb in the present tense?
20. Are items objective and observable?
21. Are criteria for acceptability spelled out clearly (size, location, precise dimensions, etc.)?
22. Can each be rated *yes* or *no*, with *yes* the desired response?
23. Is only one product characteristic included per test item?
24. Are subitems used if needed?
25. Are items written at a high-enough level to ensure the job competence of those passing the test?

2

How Can Mastery of Both Individual Tasks and Skills and Complex Learning in Real-Life Contexts Be Assessed?

What are the intended outcomes of student learning? Are learners developing an awareness of industries and the career opportunities available for technical and professional workers? Are learners exploring career pathways and the skill and knowledge requirements of those careers? Are learners preparing for employment in particular industries? Are learners who are currently employed accountable for acquiring new skills or upgrading specific skills? Answers to these questions help focus assessment on the appropriate components of the skill standards (duty area, task statement, or knowledge, skill or attribute set, problem scenario), and methodologies for assessment.

In addition to the task analyses, some industry skill standards developers have chosen to develop scenarios that capture examples of problems which frontline workers are expected to be able to solve. Scenarios have been found to be an effective way of illustrating the ways technical and professional workers integrate their intellectual, technical, and employability skills to solve problems. Scenarios provide an effective link between the education and employment communities. Within current education reform initiatives, scenarios can provide authentic assessments to ensure that students have internalized learning and can apply abstract concepts in concrete situations. As individuals transition to new workplaces, they are often faced with problem scenarios during job interviews. In industry, scenarios are often used to assess a potential new hire's level of technical information, as well as the ways he or she would approach a problem, include other work team members, and use resources.

To what level of mastery will learners be expected to demonstrate learning? At different levels of learning the questions vary:

- Are learners at the introductory level? Are they aware of the knowledge and skills, but are not required to use them? Is their curriculum limited to introduction of vocabulary, readings, and facts with only limited opportunity to visit work sites and interact with technical and professional workers?
- Are learners at the practice level? Do they understand, use, and practice industry knowledge and skills under supervision? Is their curriculum providing opportunities to understand, use, and practice industry skills with the help of frontline workers? Are learners provided with an opportunity to shadow workers and explore the industry in work-based learning?
- Are learners at the advanced or mastery level? Do they demonstrate mastery of specific skills, solve problems, integrate their knowledge with other skills/knowledge sets, and apply this learning to new situations? Are learners required to share their learning and to teach others? Are learners or incumbent workers seeking to attain professional mastery?

Each of these questions helps the assessor determine the level at which individuals are expected to demonstrate learning (introductory, practice, technical mastery, refinement, professional mastery). These questions will help determine the criteria by which learners are judged.

Depending upon the targeted level of mastery, assessment may be organized around any of the elements found in the skill standards. For example, besides developing specific skills, all learners should be building a broad understanding of the industry and the role and responsibilities of its technical and professional workers. In this case, assessment for learners who are developing an awareness of the industry might focus on an understanding of the industry's or workplace's philosophy and goals; commonly used terminology of the field; characteristics specific to workplaces representative of that industry; and the duty areas and the major skills and attributes that characterize successful professional and technical personnel.

Assessment for learners exploring that industry's pathway includes more depth and detail. Students are asked to demonstrate an understanding of the philosophy and work that leads to quality products and services, identify the duty areas by specific tasks and examples of performance indicators, or develop introductory/practice levels on some of the tasks. Learners preparing for a specific job within an industry would be required to demonstrate a range of knowledge, skills, and behaviors. This range would include mastery of the skill standards, the knowledge necessary for success, a broad and deep understanding of the philosophy and goals of the industry, the ability to solve problems that arise on the job, and the ability to build upon that learning as they continue on their career paths.

How Skill Standards Can Help

Skill standards can help ensure that the assessments of simple tasks, as well as complex problems, reveal information about what prospective workers have learned and can do in the workplace. Scenario-driven assessment, based on skill standards, ensures that students are required to demonstrate the mastery of essential skills and knowledge in ways that mirror the realities of the workplace. In real work settings, workers must decide what skills to use and how to integrate them to solve a problem. When skill standards form the basis of both competency- and scenario-based assessment, the skill standards provide a common thread that links specific skill mastery to the mastery of more complex, integrated learning required in business and industry.

CASE STUDY

Berkeley Biotechnology Education, Inc. (BBEI)

Assessing classroom and work-based learning using a variety of methods

Berkeley Biotechnology Education, Inc. employs many different student assessment methods for every part of their multifaceted program. BBEI has developed extensive classroom and lab assessment criteria, as well as student intern evaluations with the area employers. Students are assessed on all aspects of learning (the academic knowledge, the technical skills from the 14 job functions and tasks in the bioscience industry skill standards, and employability) in the different settings.

For classroom assessment and laboratory work assessments, students are given a performance rating in the areas of technical competencies (both academic and lab) and personal and interpersonal qualities (including responsibility, communication, and teamwork). (*See exhibit 7F.*)

Exhibit 7F: Performance Assessment of Student Work
(sample page)

	Exceeds Standards	Meets Standards	Below Standards	Comments
TECHNICAL COMPETENCIES				
A. Academics				
Tests:				
Mitosis				
Meiosis				
Evolution				
Weekly Reports				
Lab practical - mitosis				
B. Lab - Mitosis				
Microscope:				
Mitosis viewing				
Field diameter				
Length of cell				
Slide Preparation				
Onion root tip				
PERSONAL AND INTERPERSONAL QUALITIES				
A. Responsibility				
Attendance				
Completion of assignments				
Follows directions				
Monitors & corrects performance				
Works independently				
B. Communication				
Explains task or concept				
Organized lab notebook				
Asks questions				
Writes clearly				
C. Teamwork				
Exercises leadership				
Cooperates with others				
Teaches others				
Participates in class				
Participates within group				

Students are also assessed by a weekly report, which each student must hand in every Friday at the start of class. The report is a description of what students learned during the past week. It provides an opportunity for them to summarize the science knowledge and lab skills contained in the lessons of the week, and to ask for clarification. The report must include lab skills (e.g., making dilution's, micropipetting), knowledge (e.g., genetics, evolutionary theory), and feelings and attitudes (e.g., how the class is functioning, areas where they need help). The assessment is designed to encourage students to think about what they learned before committing their ideas to paper.

The student intern performance evaluation consists of a combination of three different evaluations—a final evaluation by the student's instructor, an evaluation by the student's site supervisor, and a student self-evaluation. The instructor helps negotiate clear objectives for the student with the site supervisor, which serve as the basis for the site evaluation. The high school site supervisor evaluations are conducted at two-week, five-week, and eight-week (final) intervals. The purpose is to assess student progress and development at each interval. The co-op students in the City College of San Francisco program are given an employer evaluation that is completed at the end of the term; it includes evaluation of judgment, initiative, and promotion potential. It also includes an attendance timetable that tracked their days and time spent at the workplace. (*See exhibit 7G.*)

The final piece of the intern evaluation is a student self-assessment, completed by the student at the end of the internship. The evaluation should reflect his or her development and performance as an intern. The student is asked questions that require "yes," "no," or "sometimes" answers, and provide space for comments. Questions asked pertaining to arrival time, whether or not the student exhibited competence, and accepted criticism.

BBEI's assessment model is unusually comprehensive. The tracking of students' development in the classroom and laboratory, as well as in the internship or co-op site, provides a complete assessment of students' growth in their knowledge base and skills over the course of the entire program. To round out the assessment model, BBEI is working on an assessment instrument for program graduates hired in full-time, training-related positions as a result of earning a science certificate in BBEI's program.

How Will We Assess Learning?

How do we assess the learner's competency or mastery of specific skills within complex situations to capture the learner's ability to use the higher-order thinking skills required in highly technical workplaces? Traditional pencil-and-paper tests and demonstration of task performance were appropriate ways of assessing workers when their jobs were narrowly focused on discrete, repetitive tasks, and when workers were not expected to take initiative, assume responsibility, and solve complex problems.

Exhibit 7G: Summer Intern Performance Evaluation

Summer Intern Performance Evaluation

Please complete evaluation and discuss in conference with intern. Return completed form to Amy Ryken (Bldg. 56B) by mail or fax. Mailing Address: P.O. Box 2586, Berkeley, CA 94702. Fax: (510) 705-5237.

Intern ______________________________ Supervisor ______________________________

Company ____

Two Week Rating _____
To be completed by July 19, 1996

Five Week Rating _____
To be completed by August 9, 1996

Eight Week Rating _____
To be completed by August 30, 1996

Be as complete and specific as possible. Place a check mark after each item in the column that best describes the individual's performance. Explain any items on which you mark "needs improvement".

O =	Outstanding	Performance is truly superior on a consistent and sustained basis.
C =	Commendable	Performance frequently exceeds normal job requirements and expectations.
G =	Good	Performance meets position requirements and expectations.
NI =	Needs Improvement	Performance does not meet all job standards, objectives, nor expectations.
NA =	Not Applicable	

	O	C	G	NI	NA	Comments
Attendance/Promptness						
Quality of Work						
Amount of Work						
Safety						
Cooperation with Others/Co-workers and Supervisors						
Organization Skills/Accurate Record Keeping						
Compliance with Good Laboratory/ Manufacturing Practices						
Attitude toward Work						
Other						
Overall						

However, as workers are required to take on new responsibilities, become cross-trained, make more decisions, and have more input into the operations of the organization, a variety of assessment methods are useful, including written tests, oral presentations, informal assessments, and performance tests. Performance tests may be more effective ways of assessing a worker's ability to succeed in complex work environments. This is especially true when learners must (a) demonstrate the integration of their skills and knowledge to solve problems and (b) identify and select the skills and knowledge sets to be used to solve the problem at hand.

EXAMPLE

San Diego City College/Center for Applied Competitive Technologies
- using portfolios to assess students' ongoing and final performance

What method do you use to capture students' ongoing and final performance? San Diego City College in California utilizes an assessment method called the Portfolio Primer to measure both throughout the semester. The Portfolio Primer is a systematic summary documentation of the student's progressive acquisition of vocational skills and behaviors. The portfolio includes the following:

- *Portfolio cover letter* — a single sheet that gives a specific reason why each assignment is included in the portfolio;
- *Chronological justification* — a one-to two-page explanation of how one protocol is linked to all the others week to week;
- *Diagnostic test correction* — a recopy of each problem the student missed on a test with an explanation of why the desired answer is correct;
- *Reagent spread sheet* — a data log that identifies key reagents used in the protocols;
- *Protocol analysis* — an analysis of the instructor's protocol including methodologies, purpose, and principles; troubleshooting tips; an example of exemplary datum and interpretation; an abstract of the entire protocol from the bioscience industry skill standards; a job function identification and illustration; and an identification of at least three attributes required or reinforced for an entry-level bioscience technical specialist;
- *Summary analysis* — a method devised by the student to easily compare results from one analysis to another. Having the student develop his or her own Portfolio Primer is exemplary because it captures and tracks student growth in all aspects of the curriculum. It asks the students to demonstrate many of the skills, knowledge, and attributes acquired throughout the course, and is evaluated by the course instructor twice in the semester.

Scenario Assessments

Many of the proponents of performance-based assessment recognize the need for developing assessments which mirror the complex nature of work today. By using real-life problem scenarios, students and incumbent workers can demonstrate the content knowledge and skills contained in the skill standards as well as the higher-order thinking skills required to make decisions and solve problems.

New York State Department of Education and Education Development Center, Inc. (EDC)

Developing scenario-based assessments for middle school, Family and Consumer Sciences (FACS) in New York

Goals 2000 is providing an opportunity for Family and Consumer Science (FACS) teachers in the state of New York to develop and field test scenario assessments based on national FACS standards. (*See exhibit 7H.*) As previously discussed in this guide, the FACS content standards were developed to support the standards-based education movement. Standards-based articulated curricula help link content standards found in academic and occupational courses to skill standards required in specific industries and careers. With technical assistance from EDC, FACS teachers are developing a process that allows teachers across the state to develop standards-based test items in a secured virtual environment.

Test questions will be presented in scenario format requiring students to respond in several ways that demonstrate targeted skill and knowledge. Besides the multiple-choice questions normally required in statewide testing, each scenario will ask students to respond to short-answer questions such as interpreting charts and graphs, one short essay question requiring the use of rubrics, and a performance test.

The development team identified the intersections between the national standards and their state FACS curriculum requirements. Using these intersections as content topics, developers generated scenarios which met the following criteria. All scenarios must have

- a real-life situation for current or future role (home, workplace, or community) which poses a problem for the student to solve;
- content in national and state standards and state curriculum;
- demonstration of skills related to three processes in Family and Consumer Sciences curriculum;
- activities or materials appropriate for all students in this course (e.g., activities or materials do not discriminate on basis of color, religion, creed, disability, marital status, veteran status, national origin, race, gender, or sexual orientation).

Some scenarios must have

- opportunities for students to apply academics as they relate to home and career skills and the situation in the scenario;
- utilization of technology as needed in solving problems.

Teachers on the development team used the following questions to guide their assessment scenario development work:

Exhibit 7H: New York State Goals 2000 Project Preliminary Draft - Scenario Assessment

Sample Scenario: Wellness Clinic

As a school nutrition counselor, you are a member of a wellness team advising students on health and nutrition issues, and helping them develop wellness plans. You focus on working with students who have special dietary needs. Sean, a 12 year old boy who is 20 lbs. overweight, wants his first meeting with you this afternoon. Sean wants to develop a wellness plan that will help him reach his ideal weight by graduation which is three months from now. Not expecting to meet with students today, you left your materials at home. Normally, during the first meeting you discuss health and dietary issues and evaluate the student's current eating patterns through a questionnaire that you have developed. Following your training outline, you guide students on making healthy food choices.

To plan your meeting with Sean, develop your questionnaire that would provide you with information to assess Sean's current eating patterns. Write up your outline of the (30 minute) training program that would guide students in making healthy food choices.

Content Skills: Evaluation of Eating Patterns
14.3.2 Apply various dietary guidelines in planning to meet nutrition and wellness needs
14.3.2 Design strategies that meet the health and nutrition requirements of individuals and families with special needs.

Additional topics:
Dietary guidelines
Label reading
Alternative good choices and substitutions
The Food Pyramid

Process Skills: Problem solving

Academic Skills:
Language Arts -
- groups and categorizes information
- uses appropriate phrasing for questions
- outlines accurately
- summarizes information

Assessment Guidelines:
For the highest proficiency rating, the answer should include

1. a well formatted questionnaire which provides all needed information to assess eating patterns (covers several days to two weeks; meals and in-between meal snacks, asks

(continued exhibit 7H)

for: information related to all groups in food pyramid, ways foods were prepared (e.g. fried, broiled) distribution of types of food throughout the day, quantity of food consumed; asks for triggers for eating e.g. what were you doing or feeling when you were eating);

2. an outline of a training program that covers the food pyramid, calorie and portion size; importance and health benefits of a balanced diet, the order in which foods are digested (sugars first, fats take longer); relationship of food intake to energy output; dietary guidelines, label reading, food substitutions, low fat, low cholesterol and low sugar diets, food allergies and low sodium foods.

For the lowest proficiency rating, the answer should include:

1. a questionnaire that provides minimally acceptable information needed to assess eating patterns (1-2 days, meals and in-between meal snacks);
2. an outline of a training program that covers the food pyramid, the importance of a diet that includes all categories of the food pyramid, and label reading.

- What is the content topic focus?
- What tasks, skills, knowledge, and attributes do we want to assess related to the content?
- What situation is the best "fit" for the content topic and knowledge, and the skills we want to assess?
- What process skills are used in bringing this scenario to resolution?
- What academic skills are employed in bringing this scenario to resolution?
- Does the draft scenario fit our criteria?
- Have we used all of the available resources in developing the scenario (criteria, matrix, process list, range of scenarios)?
- What needs to be present in the learner's response to indicate that the learner has achieved the targeted content knowledge and skill to the highest proficiency level?
- What needs to be present in the learner's response to indicate that the learner has achieved the targeted content knowledge and skill to the middle proficiency level?
- What needs to be present in the learner's response to indicate that the learner has achieved the targeted content knowledge and skill to the lowest acceptable proficiency level?

The preliminary format for assessments currently considered include preparing a bank of test items for each scenario, which reflects a variety of "types" of questions including a short essay scored with rubrics that reflect the content and process skills in context, short-answer questions which might include creation or interpretation of charts and graphs, multiple-choice test items, and open-ended questions.

The project has, thus far, written 12 scenarios, with pilot testing planned to span January to Spring 2000. Some scenarios generated by the development team will be selected for distribution across the state for use by teachers as instructional or assessment scenarios. At the end of the project, June2000, these scenarios will be available online.

San Diego City College/Center for Applied Competitive Technologies
- using the bioscience industry skill standards scenarios

San Diego City College also makes use of the bioscience industry skill standards scenario format. Guest instructors from local industries (i.e., Stratagene, IDUN Pharmaceuticals, Chiron) participate in creating scenarios for students' final exams. Each scenario is designed by a different instructor. A sample scenario-oriented exam question follows:

Question 2

You are working in a lab when your principle investigator (PI) asks you to set up a series of digests. The DNA is extracted from the hypothalamus of a Tanjanican Elephant Dog, so it is extremely rare!

a) Using EcoR1, Sac 1, and Taq 1, set up the appropriate digests using 1.0 ug of DNA per reaction.
b) Indicate a loading scheme for each of your samples.

On review of your gel, you notice a smear in the Taq 1 lane. Give some possible reasons for this phenomenon.

By using the scenario format, assessors are asking the students to synthesize.many of the different skills, knowledge, and attributes they have developed in the class—an excellent test of mastery.

Scoring Rubrics

What is a scoring rubric? How can it help you assess an individual's mastery of the skills, knowledge, and behaviors necessary for success as a technical or professional worker entering an industry?

Scoring rubrics are tools to guide the assessor in measuring the degree of knowledge, skills, and behaviors mastered by an individual student . Rubrics also allow for flexibility in the ways knowledge and skills can be demonstrated. A major benefit of using a scoring rubric is to provide consistency among assessors in identifying the types of information to seek out for analysis. Agreeing on performance levels can be challenging.

Youth Opportunities Unlimited, Inc., Sawyer College, and Cleveland One-Stop Career Center

Adding assessment guidelines to scenarios

In February 1997, Education Development Center, Inc. and Youth Opportunities Unlimited, Inc. met with the director of Cleveland's One-Stop Career Center to discuss how specific elements of standards-based education-to-employment programs could add value and consistency of quality to the emerging career centers.

Working with the Sawyer College Medical Assistant Training Program as a pilot site, the first goal was to conduct a set of program design sessions to strengthen the school-based, work-based, and connecting activities for a typical training program in the One-Stop system. In the first sessions, an initial set of challenging problem scenarios was developed. These deepened the employability, related academic knowledge, and technical skills of students preparing for medical assisting careers.

Ten nursing assistants participated in the scenario development workshop. Attendees identified topics and developed story ideas which represented typical problems many nursing assistants face during their first three years on the job. Using these stories, EDC drafted the scenarios for the nursing assistant phase of the program. They were reviewed by participants to ensure each individual scenario and the entire bank of scenarios met the set criteria.

In addition to assessment, the scenarios might be integrated into the teaching/learning process in a variety of ways. Examples include role-play activities, mini-case studies for small group or class discussion, problem solving through research and interviews with veteran nursing assistants, or as part of a student's performance evaluation. Instructors made it clear that assessment guidelines were needed for each scenario to help the instructor focus on specific skills, and to provide a sense of comfort for the instructor who may not be fully trained in scenario-based assessments. (*See exhibit 7I.*)

Whether used in school, clinical, or activities linking both, using these scenarios will help nursing assistant students

- develop the technical skills needed to perform in real work situations;
- form a deeper awareness of nursing assistant's work;
- develop higher-order thinking skills and problem solving skills;
- integrate technical, academic, and employability skills;
- link school-based technical learning with clinical experiences;
- conduct research on topics of professional interest while participating in clinical experiences;
- contemplate and practice solutions to typical situations faced in the first few years on the job.

CityLab

Utilizing a variety of assessment methods to guide student and teacher learning

The CityLab program at Boston University Medical School is a particularly dynamic example of many of the assessment methods working together. The program involves students' demonstration and mastery of many of the technical, academic, and employability skills through the use of learning scenarios. By developing scenarios that are broad, the students are given the opportunity to illustrate the diversity of their skills and knowledge in both an exciting and creative way.

In the first scenario, students are asked to demonstrate their mastery of a PCR (polymerase chain reaction) test.

- *Assessment Method 1*: When performing the PCR test in the lab, students are assessed on their technical and academic skills and knowledge. (See exhibit 7J.)

Exhibit 7I: Problem Scenario 2 for Medical Assistant Program Phase I: Nursing Assistant

Terminal Illness/with crisis

Elsie Weaver is a 63 year old woman admitted to the hospital with a diagnosis of acute GI bleeding. She currently has hematemesis and is positive for occult blood in the stool. She is in acute pain and is very frightened. She is unable to eat or drink. She has an IV in place with normal saline running at 100 cc/hr. She also has a nasogastric tube in place attached to low, intermittent suction. She has been scheduled for ultrasound tests and an endoscope. Mark Parker, a nursing assistant, has been assigned this patient. He goes in to begin his daily care with this patient.

Problem #1: What would be considered routine daily care for this patient and considerations would be most important for Mark during care for this patient?

After the patient is taken to have the ultrasound test, it is determined that she has advanced stomach cancer. Her prognosis is poor and the doctors have informing her at the bedside. After the doctors leave, her call light goes on. Mark goes in to answer it. Ms Weaver is distraught, crying and reaching out for Marks hand. "I'm so afraid."

Problem #2: How would Mark best help this patient?

Assessment Guidelines:

Problem #1: Routine daily care should include bedbath, mouth care, assessing for ROM and level of pain during administration of the bath. Special consideration should be given to the nasogastric tube not to dislodge it during movement or while washing the face. The patient should also not be placed in a flat position. Maintain HOB at no less than a 25 degree angle.

Problem #2: Communication techniques useful would be validating, reflecting, reassuring.

Exhibit 7J: The Case of the Crown Jewels

You are working in a crime lab. There has been a robbery at a jewelry store. At the scene, blood has been found on a piece of broken glass. There are two possible suspects from whom you have blood samples. DNA has been extracted from the blood samples. Your job is to use PCR to determine whether the DNA of either suspect yields evidence that it is the same DNA found at the crime scene.

This scenario pulls together many of the technical skills, particularly the basic and specific lab skills necessary to perform the PCR test, as well as part of the academic knowledge check list, and, specifically, the area of molecular biology. A few key skills and knowledge are highlighted below:

Checklist	Performance Objectives
TECHNICAL SKILLS:	
Perform PCR	Executes the procedures necessary to amplify the target strand of DNA
Perform gel electrophoresis	Executes the procedures necessary to electrophorese the amplification product
BASIC LAB SKILLS:	
Obtain and read protocol	Obtains and follows PCR protocol
Operate centrifuges	Use centrifuge appropriately
Use pipetting techniques	Identifies the proper pipet for the desired volume Use the pipet correctly
ACADEMIC KNOWLEDGE:	
Metric measurements from milliliters to microliters	Converts from microliters to milliliters and milliliters to microliters
Experimental design	Identifies and sequences the steps necessary in the PCR Procedure
	Incorporates appropriate controls in the experimental design
Written communication	

- *Assessment Method 2:* At the end of the class, students are asked to reflect on what they learned that day, either by writing index cards, a journal, or e-mail. This process helps develop communication skills through written feedback, and can be included in a portfolio.

After students complete the first scenario with the PCR test, and have found real DNA evidence, they begin the next scenario, which builds on the previous one.

> *Scenario:* DNA Court
>
> The DNA court puts the suspected jewel thieves on trial. Students are assigned roles of prosecuting team, defense team, and jury. They are to base their arguments on the DNA evidence. The teachers act as judges to moderate the discussion. Other roles can be included such as journalists, news reporters, and scientific experts. This allows other classes to be integrated, such as English, social studies, and math. The challenge is for the prosecution to clearly explain the science behind the procedure while the defense challenges it with questions. Students may also question the jury.

Not only does this scenario require use of technical communication skills and the academic knowledge checklist, but it includes many employability skills, such as resource management, interpersonal skills, information, thinking/reasoning, and personal/professional development. For example, to evaluate interpersonal skills, observe how students communicate orally; demonstrate courtesy, tact, and sensitivity toward others; work as members of a team; build consensus; and coordinate tasks with coworkers. Students are placed in positions of interdependence through this and other situations simulating the many elements of a professional working environment. The DNA court also allows students to integrate ideas and make connections in an open forum giving them a better understanding of the material, as well as the opportunity to target any misconceptions.

Other classes can be integrated by inviting them to be participants within their field. For example, the English class might send some students, who know very little about PCR, to act as reporters covering the trial for the school newspaper. Students from social studies could make up the jury, and students from law class could be the legal counsel. Mathematicians could also be called in to calculate probabilities based on the inheritance of certain polymorphisms. The groups develop an interdependence facilitating cooperative learning. The lawyers must consult the scientists to understand the results, the prosecutors must look to the reliability and integrity of the procedure, while the defendants try to understand the science and look for flaws in it. The lawyers in turn must explain what they learned in a coherent way to the jury.

CASE STUDY CONT'D

These methods of assessment allow students to display their abilities to evaluate performance in the classroom; review actual results of process; review written documentation; evaluate verbal presentation; conduct mock situational interviews; evaluate documents and exhibits; have a peer critique of journals, other materials, and performances; and examine reviews or assessments of people and procedures.

The CityLab program effectively pulls together assessment of the knowledge base, technical skills, and employability skills learned in the classroom primarily through curriculum-embedded projects (tasks that require time, not just 30—60 minute) as an extremely effective way of assessing students' mastery. This program offers an exciting and innovative way to challenge students and have them fully involved in the demonstration of their knowledge and capabilities.

Judging the results of these types of assessments fairly is a more difficult proposition than scoring a multiple-choice test. Establishing robust scoring rubrics is one way of meeting this challenge.

EXAMPLE

Human Services Research Institute, Inc. (HSRI) and Education Development Center, Inc. (EDC) - *developing five performance levels for assessing performance*

HSRI, EDC, and frontline workers developed skill standards and implementation guidelines for the community support worker skill standards (for human services). During the initial framework development, three important assessment levels of skill standards mastery emerged: introductory level, practice level, and mastery level.

About midway through the project, the curriculum team (consisting of educators and industry trainers) discussed the changes in the ways an individual demonstrated mastery of skills within a continuum beginning in school and extending with job performance. Prior to this discussion, levels of mastery were assessed within education and training programs leading to work in the industry. However, as the discussion evolved, the curriculum team began to consider the incumbent worker's continued skill development and how that skill development translated into identifiable levels of mastery along the education-to-employment continuum. A teacher would very likely define mastery of a standard differently than would a job site supervisor who is evaluating an incumbent worker. If skill standards are to be useful to both educators in creating programs leading to work in an industry and employers for retraining incumbent workers, the three-point scale was insufficient. All the levels of mastery and maturity were not reflected. The team extended the three-point scale to a five-point scale, bridging the education-to-employment transition by making the same skill standards useful in both settings.

As individuals progress through the career pathway, developing knowledge and skills leading to a cluster of occupations within an industry, they move through five levels of performance against industry skill standards.

I = Introductory level
P = Practice level
M= Technical mastery level
R = Refinement level
E =Expert/Professional level

WestEd - *"C-TAP" scenario assessments*

WestEd, a research and development laboratory in Berkeley, California, developed a testing process based on scenarios and rubrics to assess students' performance in occupational areas. This example illustrates a scoring rubric for a scenario about first aid.

Scenario: First Aid for a Choking Victim

Five preschool children are sitting around a large table having lunch at the day care center. Richard and Raffy, both four years old, are joking with each other. Raffy tickles Richard, and Richard laughs with a mouthful of food. Suddenly, Richard begins to choke, has trouble breathing, and cannot talk. The teacher rushes over to Richard, pats his back with several strokes, and offers him a drink of juice.

Instructions:
Consider what you have learned about helping a choking victim. Explain whether or not the teacher reacted correctly. Write a short essay describing what you would do in this situation. Describe and explain what steps you would take after giving first aid. Tell what you would do with the whole class. Give reasons for what you suggest.
To receive a proficient rating on this task, you must demonstrate the following:

Knowledge of

first aid procedures,
child growth and development,
operational procedures,
standards and licensing regulations, as related to this situation;

Ability to propose a solution to the scenario;
Ability to communicate effectively in writing.

Education Development Center, Inc. (EDC) - *levels of mastery and their implications for assessment*

From working with various partners in the development and implementation of skill standards in bioscience, human services, manufacturing, and chemical process industries, Education Development Center, Inc. found that levels of mastery have certain implications for assessment. We developed the following chart to illustrate the implications of five levels of mastery for assessment. As students progress from introductory to expert/professional levels, the expectations become greater for them to demonstrate, through action, their mastery of the skills and knowledge required of the industry. (*See exhibit 7K.*)

Exhibit 7K: Levels of Knowledge/Skills Mastery

Levels of Mastery	Implications for Assessment
Introductory Level - learning is characterized by research, reading, observation, and memorization. Key words: Facts Vocabulary Concepts Applications	Individual assessments of knowledge and concepts: Self-checks Knowledge tests Written tests and quizzes Oral quizzes Short essay questions Multiple choice, fill in blank and short answer tests Analysis/synthesis of readings
Practice Level - learning is characterized by individual and group practice work, research, analysis and interpretation, and individual practice work on skill standards. Key terms: Understand Practice Interpret Assess Maintain records	Assessments become more active, students are engaged in teams: Written tests, quizzes Observation Portfolios Team assessments Projects
Proficient (Technical Mastery) Level - Learning is characterized by developing technical mastery of skill standards, self improvement through practice, reflection, coaching from peers, teachers and mentors, and solving of real workplace problems. Key words: Mastery Problem solving Integration Individual performance Skill transfer to new situations Teach others	Knowledge tests focus on higher level analysis, synthesis, and ability for student to apply what is learned, solve problems, and extend learning to new situations. Although group assessment continues, more attention is focused on individual performance assessment against criteria for skill mastery. Time becomes a factor in assessment. Students are expected to be able to perform routine work and solve problems commonly found in the workplace in real-time. Successful completion of this level indicates a pre-employment mastery of knowledge and skills.
Refinement Level - Learning is characterized by continuous improvement, upgrading, and refinement of technically mastered skills. Key words: Refinement Quality Control Indicators Continuous Improvement	Once employed, individuals are assessed on the degree to which their skills and knowledge meet industry standards and are useful in specific work situations. Continuous improvement guides assessment at this level. Assessment becomes more of a collaborative process between the individual and his/her teacher/supervisor/mentor, who identify and work to strengthen weak areas and identify as well as refine strengths. Assessment primarily focuses on individual performance in real work roles, in real time and focuses on observation, performance assessments, internal/external customer satisfaction, and ability to acquire new skills and knowledge as needed

Conclusion

Many educators feel more confident in their abilities to teach than to develop and use assessment techniques. Yet, there are many ways educators have dealt with skill standards and assessing the skills and knowledge of potential workers; for example,

- assessing specific tasks, skills, knowledge, or competencies against a specific intended outcome;
- assessing the methods by which skills and knowledge are demonstrated within real work situations that require skills and knowledge integration across disciplines.

Although assessment can be a complicated issue, these stories from the field can help educators and trainers unfamiliar with industry skill standards start to think about assessment issues, and make preliminary decisions about how to begin implementing skill standards-based assessments.

Appendix A

Original Pilot Voluntary Industry Skill Standards Projects

Funded either by the U.S. Department of Education or the U.S. Department of Labor

Chemical Processing
American Chemical Society
Kenneth Chapman
1155 NW 16th Street
Washington, DC 20016
P: (202) 872-8734 F: (202) 872-8068

Electronics
American Electronics Association
Andrea Fiorelli
5201 Great American Prkwy, Bx 54990
Santa Clara, CA 95056
P: (800) 284-4232 F: (408) 970-8565
Direct: (408) 987-4241
I: www.aeanet.org

Welding
American Welding Society
Nelson Wall
550 NW LeJeune Road
Miami, FL 33126
P: (305) 443-9353, ext. 211 F: (305) 443-7559

Hazardous Materials Management Technology, Photonics
Center for Occupational Research and Development
Photonics Hazardous Materials
Darrell Hull / James Johnson
601 Lake Air Drive
Waco, TX 76710
P: (817) 772-8756 F: (817) 772-8972

Hospitality and Tourism
Council on Hotel, Resturant and Institutional Education
Susan Dowler
1200 17th Street, NW
Washington, DC 20036-3097
P: (202) 331-5990 F: (202) 785-2511
I: www.chrie.org

Bioscience
Education Development Center, Inc.
Judy Leff
55 Chapel Street
Newton, MA 02458-1060
P: (617) 969-7100 F: (617) 332-4318
I: www.edc.org

Electronics
Electronics Industries Foundation
Walter Seymour
Electronics Industries Association/CEMA
2500 Wilson Boulevard, Suite 210
Arlington, VA 22201-3834
P: (703) 907-7411 F: (703) 907-7401
I: www.eia.org

Agricultural Biotechnology
National FFA Foundation
Bernard Staller
PO Box 15160
Alexandria, VA 22309-0160
P: (703) 360-3600 F: (703) 360-5524
E: foundation@ffa.org
I: www.ffa.org

Printing
Graphic Arts Technical Foundation
Bill Smith
National Council for Skill Standards in Graphic Communications
208 Lafayette Center
Kennebunk, ME 04043
P: (207) 985-9898 F: (207) 985-6347

Grocery
Grocers Research and Education Fund
Gail Hanger
1825 Samuel Morse Drive
Reston, VA 22090
P: (703) 437-5300 F: (703) 437-7768

Human Services
Human Services Research Institute
Marianne Taylor
2336 Massachusetts Avenue
Cambridge, MA 02140
P: (617) 876-0426 F: (617) 492-7401
E: mtaylor2@concentric.net
I: www.hsri.org

Heavy Highway/Construction & Environmental Remed.
Labor-Associated General Contractors Education and Training Fund
John Tippie
AGC Education & Training Fund
27055 Ohio Avenue, P.O. Box 479
Kingston, WA 98346
P: (360) 297-4152 F: (360) 297-3368

Automobile, Autobody, Medium/Heavy Truck Technicians
National Automotive Technicians Education Foundation
Pat Lundquist
13505 Dulles Technology Drive
Herndon, VA 20171-3421
P: (703) 713-0100 F: (703) 793-6544
I: www.natef.org

Computer-Aided Drafting and Design, Advanced Manufacturing Technical Workers
National Coalition for Advanced Manufacturing
Computer-Aided Drafting and Design
Advanced Manufacturing Technical Workers
C.J. Shroll
1331 Pennsylvania Avenue, NW
Suite 1410, North Tower
Washington, DC 20004-1703
P: (202) 662-8968 F: (202) 662-8969

Electrical Construction
National Electronic Contractors Association
Charles Kelly
Three Bethesda Metro Center, Suite 1100
Bethesda, MD 20814-5372
P: (310) 657-3110 F: (310) 215-4545

Advanced High-Performance Manufacturing
National Skill Standards for Advanced Manufacturing
C.J. Shroll
1201 New York Avenue, NW
Suite 725
Washington, DC 20005-3917
P: (202) 216-2742 F: (202) 289-7642

National Retail Federation
Katherine Mannes
325 7th Street, NW
Washington, DC 20004
P: (202) 626-8110
I: www.nrf.com/nri

Metalworking
National Institute for Metalworking Skills
Robert Sherman
10301 Democracy Lane, Suite 407
Fairfax, VA 22030
P: (703) 352-4971 F: (703) 352-4991
I: www.nims-skills.org

Industrial Laundry
Uniform and Textile Service Assoication
David Dunlap
1300 North 17th Street, Suite 750
Rosslyn, VA 22209
P: (703) 247-2608 F: (703) 841-4750
I: www.utsa.com

Air Conditioning, Heating, and Refrigeration
V-TECS
Ronald McCage
Southern Assoc. of Colleges and Schools
1866 Southern Lane
Decatur, GA 30033-4097
P: (800) 248-7701 F: (404) 679-4556
I: www.mindspring.com/~vtecs

Health Care
WestEd (formerly Far West Lab)
Sri Ananda
730 Harrison Street
San Francisco, CA 94107-1242
P: (415) 565-3000 F: (415) 565-3012

Other Skill Standards

Information Technology
NorthWest Center for Emerging Technology
3000 Landerholm Circle, SE
Bellevue, WA 98007-6484
P: (425) 373-4215 F: (425) 562-6193

Administrative Support
V-TECS
Ronald McCage
Southern Assoc. of Colleges and Schools
1866 Southern Lane
Decatur, GA 30033-4097
P: (800) 248-7701 F: (404) 679-4556
I: www.mindspring.com/~vtecs

Telecommunications
South King County Tech Prep Consortium
12401 SE 320th Street
Auburn, WA 98092-3699
P: (253) 833-9111 ext. 2581

Continuation Projects

NSSB funded the following organizations to conduct projects and produce materials that build on the work of the original industry skill standards demonstration projects:

American Chemical Society
American Electronics Association
Center for Occupational Research and Development
Council on Hotel, Restaurant, and Institutional Education
Education Development Center, Inc.
Human Services Research Institute
Laborers-AGC Education and Training Fund
National FAA Foundation
National Retail Federation
WestEd

Appendix B

Resource Directory of Case Studies and Examples

Abraham Lincoln High School
2162 24th Avenue
San Francisco, CA 94116
Contact Information:
George Cachianes
P: (415) 759-2700 F: (415) 566-2224
E: gcachia@sfusd.k12.ca.us

Alamance Community College
P.O. Box 8000
Graham, NC 27253-8000
Contact Information:
Bill Woodruff
P: (910) 578-8727 ext.2131 F: (910) 578-1987
E: woodruff@alamance.cc.nc.us

Altus High School
400 North Park Avenue
Altus, OK 73521
Contact Information:
Bruce Farquhar
P: (580) 481-2167

American Chemical Society
1155 16th Street, NW
Washington, DC 20036
Contact Information:
Sam Stevenson
P: (202) 872-8734 F: (202) 872-6336
E: s_stevenson@acs.org
I: www.acs.org

American Electronics Association
5201 Great America Parkway, Box 54990
Santa Clara, CA 95054
Contact Information:
Cheryl Fields Tyler
P: (408) 987-4200 F: (408) 970-8565
I: www.aeanet.org

Baltimore City Community College
2901 Liberty Heights Avenue
Baltimore, MD 21215
Contact Information:
Kathleen Norris
P: (410) 462-7653 F: (410) 462-8437
E: knorris@bccc.state.md.us
I: www.bccc.state.md.us

Bay Area Biotechnology Education Consortium (BABEC)
101 Twin Dolphin Drive
Redwood City, CA 94065
Contact Information:
Desmond Mascarenhas (at Celtrix Pharmaceuticals)
P: (408) 450-4707 F: (408) 450-4700
E: desmond@celtrix.com
I: www.babec.org

Berkeley Biotechnology Education Inc.
800 Dwight Way
Berkeley, CA 94710
Contact Information:
Cheyl Franklin-Golden, Director
P: (510) 705-5149 F: (510) 705-5237
I: www.bayerpharma-na.com/community/ba04.asp

BIOCOM
4940 Carroll Canyon Road
San Diego, CA 92121
Contact Information:
A. Stephen Dahms
P: (619) 455-0300 F: (619) 455-0022
I: www.biocom.org

Bio-Link: A National Advanced Technology Center for Biotechnology
City College of San Francisco
50 Phelan Avenue, Box S-12
San Francisco, CA 94112
Contact Information:
Elaine Johnson
P: (415) 239-3500 F: (817) 772-8972
E: ejohnson@ccsf.cc.ca.us
I: bio-link.org

BioPharmaceutical Technology Center Institute
5445 E. Cheryl Parkway
Madison, WI 53704
Contact Information:
Karin Borgh
P: (608) 277-6992 F: (608) 273-6992
E: kborgh@promega.com
I: www.btci.org

Building Linkages
National School-to-Work Office
400 Virginia Avenue, SW
Washington, DC 20024
Contact Information:
P: (202) 401-6222 F: (202) 401-6211
I: www.stw.ed.gov

California Foundation for Agriculture in the Classroom
2300 River Plaza Drive
Sacramento, CA 95833-3293
Contact Information:
Pamela Emery
P: (916) 561-5625 or (800) 700-AITC
F: (916) 561-5697
E: pemery@cfbf.com
I: www.cfaitc.org

California State University, Hayward
Department of Biological Sciences
25800 Carlos Bee Blvd.
Hayward, CA 94542-9988
Contact Information:
Stephen Benson
P: (510) 885-3471
E: sbenson@csuhayward.edu
I: www.csuhayward.edu/acaprogs/biotech

California State University, Hayward
Department of Teacher Education
25800 Carlos Bee Blvd.
Hayward, CA 94542-9988
Contact Information:
Dave Stronck
P: (510) 885-3005 F: (510) 885-4632
E: dstronck@csuhayward.edu

Center for Occupational Research and Development (CORD)
P.O. Box 21689
Waco, TX 76702-1689
Contact Information:
P: (800) 972-2766 F: (254) 772-8972
I: www.cord.org

Chautauqua Short Courses Program
Department of Materials Science and Engineering
323 Benedum Hall
University of Pittsburgh
Pittsburgh, PA 15261
Contact Information:
Nicholas G. Eror
P: (412) 624-9761 F: (412) 624-1108
I: www.engrng.pitt.edu/~chautauq/

City College of San Francisco
School of Applied Science and Technology
1400 Evans Avenue
San Francisco, CA 94112
Contact Information:
Phil Jardim, Program Director
Elaine Johnson, Program Coordinator
P: (415) 239-3500 F: (415) 550-4400
E: ejohnson@ccsf.cc.ca.us
I: www.ccsf.cc.ca.us/departments/
school_of_applied_science_and_technology

CityLab Academy
Boston University, School of Medicine
715 Albany Street, S-408
Boston, MA 02118
Contact Information:
Connie Philips
P: (617) 638-5622 F: (617) 638-5621
E: cphilli@bu.edu
I: www.bumc.bu.edu/departments

City University of New York (CUNY)
Consortium for the Study of Disabilities
535 E. 80th Street
New York, NY 10021
Contact Information:
William Ebenstein
P: (212) 794-5486 F: (212) 794-5706
I: www.cuny.edu

Cleveland One-Stop Career Center
City of Cleveland
1701 E. 13th Street
Cleveland, OH 44114
Contact Information:
Robyn Gordon
P: (216) 664-4518 F: (216) 664-2951

Columbus Center of Marine Biotechnology (Contact Center of Marine Biotechnology)
Suite 236, 701 East Pratt St.
Baltimore, MD 21202
Contact Information:
P: (410) 234-8800 F: (410) 234-8896
I: www.umbi.umd.edu/~comb

Contra Costa Community College
2600 Mission Bell Drive
San Pablo, CA 94806
Contact Information:
P: (510) 235-7800 ext. 4288
F: (510) 236-6768

East Cleveland School District, UROG
Sims Building
15305 Terrace Road
E. Cleveland, OH 44112
Contact Information:
Craig Dorn
P: (216) 268-6439 F: (216) 268-6499

Education Development Center, Inc. Center for Education, Employment, and Community
55 Chapel Street
Newton, MA 02458
Contact Information:
Judy Leff/Joyce Malyn-Smith
P: (617) 969-7100 F: (617) 332-4318
I: www.edc.org

EDVOTEK, Inc.
Contact Information:
Jack Chirikjian
Georgetown University Medical Center
3900 Reservoir Road, N.W.
Washington, DC 20007
P: (202) 687-2160 F: (202) 687-2232

Family and Consumer Sciences: New York State Goals 2000 Project
N.Y. State Department of Education
89 Washington St.
Albany, N.Y. 12234
Contact Information:
Marilyn Kucera
P: (518) 474-5506 F: (518) 474-1989

Foothill College
Biotechnology Program
12345 El Monte Road
Los Altos Hills, CA 94022-4599
Contact Information:
Celeste Carter
P: (650) 949-7041
I: www.cipb.org/cases

Genentech, Inc., Access Excellence
460 Point San Bruno Blvd.
South San Francisco, CA 94080
Contact Information:
Geoff Teeter
P: (650) 225-8171 F: (650) 225-1657
I: www.gene.com/ae

Greater Baltimore Advanced Technology Center
800 South Rolling Road
Baltimore, MD 21228
Contact Information:
Mildred Boyd
P: (410) 455-4191 F: (410) 455-4952

Human Services Research Institute
2336 Massachusetts Ave.
Cambridge, MA 02140
Contact Information:
Marianne Taylor
P: (617) 876-0426 ext. 330
F: (617) 492-7401
I: www.hsri.org

Indiana Essential Skills and Technical Proficiencies Initiative
2416 Shawnee
Okemos, MI 48864
Contact Information:
Chris Olson
P: (517) 349-9191

Keene State College
229 Main Street
Keene, NH 03435
Contact Information:
Homer Stavely
P: (603) 352-1909
I: www.keene.edu

Lawrence Berkeley National Laboratory
One Cyclotron Road,
Berkeley, CA 94720
Contact Information:
Laurel Egenberger
P: (510) 486-4000 ext. 5190
F: (510) 486-5717
I: www.lbl.gov

Madison Area Technical Colege
3550 Anderson Street
Madison, WI 53704
Contact Information:
Joy McMillan
P: (608) 246-6100 F: (608) 246-6800
E: Jmcmillan@Madison.tec.wi.us
I: www.madison.tec.wi.us/catalog/pages

Madison Park Vocational Technical High School, Boston Integration Project
75 Dudley Street
Boston, MA 02120-3106
Contact Information:
Lynda Culver
P: (617) 635-8079 F: (617) 635-9831
I: www.boston.k12.ma.us/schools/rc657.asp

MassJobs Council School-to-Work Task Force
One Ashburton Place, Room 2111
Boston, MA 02108
Contact Information:
Susan Phillips
P: (617) 727-7944
I: www.state.ma.us/massjobs/council.htm

Minuteman Science-Technology High School: Biotechnology Academy
758 Marrett Road
Lexington, MA 02173
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Appendix C

Related Readings

Agricultural Biotechnology: Issues and Choices. Baumgardt, Bill, and Martin, Marshall. West Lafayette, IN: Purdue University Agricultural Experiment Station. (1991).

America's Choice: High Skills or Low Wages! National Center on Education and the Economy. Rochester, NY: National Center on Education and the Economy. (1990).

Animal Biotechnology and the Ethics of Hybridization. Thompson, Paul. Texas: A&M University. Center for Biotechnology Policy & Ethics. (1994).

Applying the Standard: Using Industry Skill Standards to Improve Curriculum and Instruction: Lessons Learned from Early Implementers in Four States. Klein, Steven, G., et al. Berkeley, CA: MPR Associates. (1996).

Applying the Standard: Using Industry Skill Standards to Improve Curriculum and Instruction: Volume II Case Study Summaries. Klein, Steven, G., et al. Berkeley, CA: MPR Associates. (1996).

Assessing Student Outcomes: Performance Assessment Using the Dimensions of Learning Model. Marzano, Robert, et al. Alexandria, VA: Association for Supervision and Curriculum Development. (1993).

Bioscience Education and Training Program Directory. Education Development Center, Inc. Newton, MA: Education Development Center, Inc. (1995).

Biotechnics and Society: The Rise of Industrial Genetics. New York: Praeger. (1991).

Biotechnology Resources for Teachers: A Sourcebook of Classroom Activities, Support Materials, Lesson Plans, Labs, and Visual Aids. Massachusetts Biotechnology Research Institute. (1994).

The Brave New World of Animal Biotechnology. Donnelley, S., et al. (This is a special supplement to the Hastings Center Report, 24, no. 1). Contact: The Hastings Center, 255 Elm Road, Briarcliff Manor, NY 10510.

Chart Your Course-Building Partnership Set. Ingvoldstad, Mert: Center for Educational Development.(1989).

Education and Work: Designing Integrated Curricula. Edling, Walter, and Loring, Ruth. Waco, TX: Center for Occupational Research and Development. (1996)

Education and Work: Toward an Integrated Curriculum Framework. Prescott, Carolyn, A., et al. Waco, Texas: Center for Occupational Research and Development. (1996).

The Employer Connection: State Strategies for Building School-to-Work Partnerships. National Governors Association. Washington, DC: National Governors Association. (1996).

The Evolution and Development of Biotechnology. A Revolutionary Force in American Agriculture. Schor, Joel. Washington, DC: Economic Research Service, U.S. Department of Agriculture. (1994).

Exploring Work: Fun Activities for Girls. Newton, MA: WEEA Equity Resource Center. (1996).

Gateway to the Future: Skill Standards for the Bioscience Industry. Education Development Center, Inc. Newton, MA: Education Development Center, Inc. (1995).

Getting to Work. MPR Associates. Berkeley, CA: MPR Associates. (1996).

Handbook for Developing Competency-Based Training Programs. Blank, William E. Tampa, FL: University of South Florida. (1982).

High School Mathematics at Work: Essays and Examples for the Education of All Students. National Research Council. Mathematics Sciences Education Board. (1998).

In the Backrooms of Science: Notes on the Work of Technicians in Science Labs. Bechky, Beth, and Barley, Stephen. Philadelphia, PA: National Center on the Educational Quality of the Workforce. (1992).

Integrating Academic and Industry Skill Standards. Bailey, Thomas. Berkeley, CA: National Center for Research in Vocational Education. (1997).

Implementation Guide for Occupational Skill Standards: Agricultural Biotechnology Technician. National FFA Foundation. Madison, WI: National FFA Foundation. (1996).

Learning a Living: A Blueprint for High Performance. U.S. Department of Labor, The Secretary's Commission on Achieving Necessary Skills. Washington. DC. (1992).

Meeting the American Electronics Association Standards. American Electronics Association, & N. Seattle Community College. Seattle, WA: N. Seattle Community College. (1997).

Making Sense of Industry-Based Skill Standards. Bailey, Thomas, and Merritt, Donna. National Center for Research on Vocational Education. Berkeley, CA. (1995).

Milestones in Biotechnology: Classic Papers on Genetic Engineering. Davies, Julian, and Reznikoff, William. Boston: Butterworth-Heinemann. (1992).

The Mindful Worker: Learning and Working Into the 21st Century. Miles, Curtis. Clearwater, FL: H&H Publishing Company. (1994).

A National Policy for Workplace Training: Lessons From State and Local Experiments. Batt, Rosemary, and Osterman, Paul. Washington, DC: Economic Policy Institute. (1993).

National Skill Standards Board: Voluntary Skill Standards: A System to Build Better Jobs and Better Business Results. National Skill Standards Board. Washington, DC: National Skill Standards Board. (1997).

New Crops, New Uses, New Markets: Industrial and Commercial Products From U.S. Agriculture, 1992 Yearbook of Agriculture (USDA). Contact: Superintendent of Documents, (202) 224-8996.

A Pedagogy Blueprint for the 21st Century: Pedagogy and Assessment Implications of "Using Voluntary National Skill Standards in Performance Based Design." Marashio, Paul, and Marashio, Nancy. New Hampshire Community Technical College System. (1996).

Performance Assessment Systems: Implications for a National System of Skill Standards. Wirt, John. Washington, DC: National Governors Association. (1994).

Performance Assessment Systems: Implications for a National System of Skill Standards, Volume II—Technical Report. Wirt, John. Washington, DC: National Governors Association. (1995).

Performance Standards (elementary, middle and/or high school). New Standards Project, National Center on Education and the Economy. (1997).

Project SMART: Local Manufacturing Industry Skill Standards. Youth Opportunities Unlimited. Newton, MA: Education Development Center Inc., (1996).

Project SMART: Work-Based Learning in the Manufacturing Firm. Youth Opportunities Unlimited. Newton, MA: Education Development Center, Inc. (1997).

SCANS: Blueprint for Action: Building Community Coalitions. SCANS. Washington, DC: U.S. Department of Labor. (1991).

School-Based Reform, Lessons from a National Study. Department of Education. (1995).

School-to-Work and Community Economic Development: Identifying Common Ground. Jobs for the Future. Boston, MA: Jobs for the Future. (1995).

School-to-Work: Equitable Outcomes. Equity in Education Series. WEEA Publishing Center. (1995).

School-to-Work: Jump-Start Equity Kit. WEEA Equity Resource Center (1995).

Skill Standards: Benchmarks of Excellence. National Alliance of Business. Washington, DC. (1995).

Skill Standards: Concepts and Practices in State and Local Education. Klein, Steven, G., et al. Berkeley, CA: MPR Associates. (1996).

Skill Standards in Context: Models of the Technician's Work (Draft). Barley, Stephen, and Hofstader, Robert.

Solving Agricultural Problems with Biotechnology. Washington, DC: U.S. Department of Agriculture. Agricultural Research Service. (1990).

Standards: Making Them Useful and Workable for the Education Enterprise. Wills, Joan. Washington, DC: U.S. Department of Education. (1997).

A Tool for State Workforce Development System Reform - Final Report. Ganzglass, Evelyn and Simon, Martin. National Governors Association. Washington, DC. (1995).

Training Partnerships: Linking Employers and Providers. Carnevale, Anthony, P., et al. Washington, DC: The American Society for Training & Development. (1990).

Using Scenarios as a Basis for Curriculum That Integrates Requirements of Boston Public Schools Learning Standards and Industry Skill Standards: A Manual for Teachers. Leff, Judith, and Malyn-Smith, Joyce. Newton, MA: Education Development Center, Inc. (1997).

Voluntary Industry Skill Standards-Integrated Standards and Equity. Malyn-Smith, Joyce, and Guilfoy, Vivian. Newton, MA: Education Development Center, Inc.

What Work Requires of Schools: A SCANS Report for America 2000. SCANS. Washington, DC: U.S. Department of Labor. (1991).

Who Will Do the Work? National Alliance of Business. Washington, DC: National Alliance of Business. (1989).

Work-Based Learning: The Key to School-to-Work Transition. Hoerner, J. L., and Wehrley, J. B. Westerville, Ohio: Glenco/McGraw-Hill. (1995).

Working to Learn. Cambridge, MA: TERC. (1998).

Work Keys: National System for Teaching and Assessing Employability Skills. American College Testing. Iowa City, Iowa: American College Testing. (1991).

Workforce, Economic, and Community Development: The Changing Landscape of the Entrepreneurial Community College. Grubb, N. W., et al. Washington, DC: U.S. Department of Education. (1997).

The Workforce Training Imperative: Meeting the Needs of the Nation, A Policy Paper on the Role of Community Colleges in Providing Workforce Training. Washington, DC: American Association of Community Colleges. (1993).

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- working with industry and educators to develop national industry skill standards to guide education program development;
- assisting school systems in integrating industry skill standards into curricula and teaching strategies, or developing new curricula and pedagogy to meet industry skill standards;
- helping communities improve levels of English, mathematics, science and technology education to prepare students for higher education and work in modern workplaces;
- assisting communities in fostering practices that support equity and cultural diversity.

EDC directed the development of the national skill standards for the bioscience industry, with a grant from the U.S. Department of Education. EDC then received a grant from the National Skill Standards Board to create Implementation Guidelines and Curriculum Frameworks for the using skill standards. The result of this work is this manual - *Making Skill Standards Work: Highlights from the Field.*

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The National FFA Foundation, Inc. is a not-for-profit foundation, created in 1944 to provide financial support for and assistance to agricultural education in the United States. Contributions to the foundation are tax exempt. The foundation supports FFA activities, including assistance for postsecondary agricultural students, the FFA Alumni Association, the National Vocational Agriculture Teachers Association, the National Young Farmers Educational Association/Institute, and the Council for Agricultural Education. The mission of FFA is to make a positive difference in the lives of students by developing their potential for premier leadership, personal growth, and career success through agricultural education.

The FFA directed the development of the national agricultural biotechnician skill standards, with the assistance of its many member companies. Under subcontract to Education Development Center, Inc., the foundation worked with EDC, and a large number of educators and company representatives, to merge the academic skills, technical skills, and employability skills required under its skill standards with those identified in the national bioscience skill standards into one broad set of requirements that encompasses both sets of skill standards. Corporate and educational members also participated in workshops and meetings to provide information used to create the implementation guidelines in *Making Skill Standards Work: Highlights from the Field.* The FFA codirector of this project contributed to the writing of the manual.

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